

# Management Protocols *in* **ICU**

*Prepared by:*  
Anaesthesia Programme &  
Cawangan Kualiti Penjagaan Kesihatan,  
Bahagian Perkembangan Perubatan  
Kementerian Kesihatan Malaysia &  
Malaysian Society of Intensive Care

August 2012

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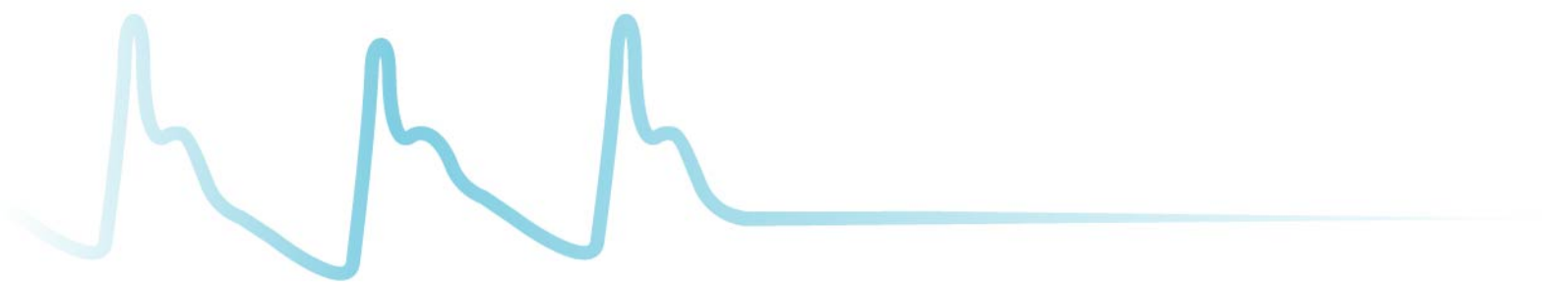
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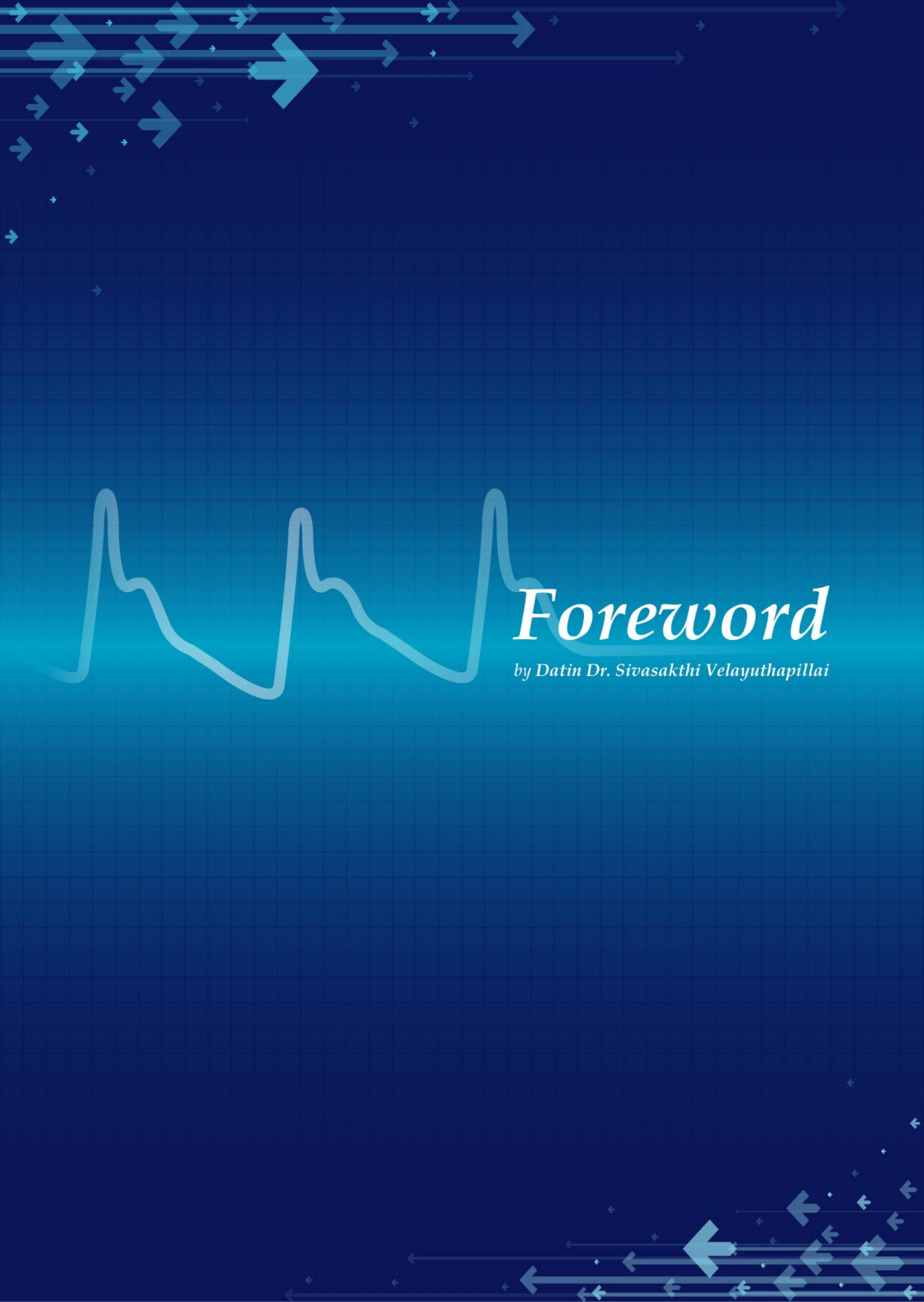
table of

# Content

<b>Foreword</b>	<b>07</b>
<b>List of Management Protocols</b>	<b>08</b>
<b>ICU Management Protocol No. 1</b> <i>Admission and Discharge Policy in the Intensive Care Unit</i>	<b>10</b>
<b>ICU Management Protocol No. 2</b> <i>Investigations and Microbiological Surveillance in the Intensive Care Unit</i>	<b>16</b>
<b>ICU Management Protocol No. 3</b> <i>Ventilatory Strategies in Severe Hypoxemic Respiratory Failure</i>	<b>19</b>
<b>ICU Management Protocol No. 4</b> <i>Weaning from Mechanical Ventilation in the Intensive Care Unit</i>	<b>25</b>
<b>ICU Management Protocol No. 5</b> <i>Inotropic and Vasopressor Support in Intensive Care</i>	<b>35</b>
<b>ICU Management Protocol No. 6</b> <i>Enteral and Parenteral Nutrition in the Intensive Care Unit</i>	<b>42</b>
<b>ICU Management Protocol No. 7</b> <i>Sedation and Delirium in the Intensive Care Unit</i>	<b>51</b>
<b>ICU Management Protocol No. 8</b> <i>Venous Thromboembolism Prophylaxis</i>	<b>63</b>
<b>ICU Management Protocol No. 9</b> <i>Stress Related Mucosal Disease (SRMD) Prophylaxis in The Intensive Care Unit</i>	<b>70</b>



<b>ICU Management Protocol No. 10</b> <i>Blood Glucose Management in the Intensive Care Unit: Insulin Infusion Protocol</i>	<b>73</b>
<b>ICU Management Protocol No. 11</b> <i>Early Mobilization for Patients in the Intensive Care Unit</i>	<b>76</b>
<b>ICU Management Protocol No. 12</b> <i>Withholding and Withdrawal of Life Support Therapy in the Intensive Care Unit</i>	<b>80</b>
<b>ICU Management Protocol No. 13</b> <i>Policy on Mechanical Ventilation outside the Intensive Care Unit</i>	<b>86</b>



# *Foreword*

*by Datin Dr. Sivasakthi Velayuthapillai*

Dear colleagues,

I am indeed honoured to be given an opportunity to write a message to you all. Ten protocols were first introduced in Aug 2006 by our esteemed predecessor Dr Ng SiewHian in all Ministry of Health Intensive Care Units. With that, we saw a definite improvement in patient outcome and resource utilization in the Intensive Care Units.

This year, our Intensive Care Colleagues and the Quality Unit in Ministry of Health have ventured further and we are now proud to be able to present to you another 11 management protocols and 2 policies that will cover a diverse range of topics involved in the care of critically in patients. Doctors and staff working in critical care areas face a great challenge in ensuring adequate implementation of these protocols and auditing the outcome end points after its successful implementation. Doctors have to be constantly knowledgeable about new evidences and be instrumental in promoting changes if necessary.

I am confident that we will be able to march towards these challenges.

Thank you once again to our intensive care colleagues and the support from Quality division and MOH.

**Datin Dr. Sivasakthi Velayuthapillai**

Head of the Department of Anaesthesia and Intensive Care  
Kuala Lumpur Hospital  
August 2012

The protocols may be downloaded from the following websites:

*Malaysian Registry of Intensive Care: [www.mric.org.my](http://www.mric.org.my)*

*Malaysian Society of Intensive Care: [www.msic.org.my](http://www.msic.org.my)*



## List of Management Protocols

No.	Title	Prepared by
1.	Admission and Discharge Policy	Dr. Tan Cheng Cheng
2.	Investigations and Surveillance	Dr. Lim Chew Har
3.	Ventilatory Strategies in Severe Hypoxemic Respiratory Failure	Dr. Tai Li Ling
4.	Weaning From Mechanical Ventilation	Dr. Khoo Tien Meng
5.	Inotropic and Vasopressor Support	Dr. Md Ridhwan Md Noor
6.	Enteral and Parenteral Nutrition	Dr. Jenny Tong May Geok
7.	Sedation and Delirium	Dr. Shanti Rudra Deva
8.	Venous Thromboembolism Prophylaxis	Dr. Ahmad Shaltut Othman
9.	Stress Related Mucosal Disease Prophylaxis	Dr. Noor Airini Ibrahim
10.	Blood Glucose Management - Insulin Infusion Protocol	Dr. Mohd Basri Mat Nor
11.	Early Mobilization	Dr. Lee See Pheng
12.	Withholding and Withdrawal of Life Support Therapy	Dr. Laila Kamaliah Kamalul Bahrin
13.	Policy on Mechanical Ventilation outside the Intensive Care Unit	Dr. Tan Cheng Cheng



*ICU Management*  
*Protocol No.*

**1-13**

# Admission and Discharge Policy in the Intensive Care Unit

### Introduction

Intensive care refers to care provided in a separate, specially-staffed and equipped hospital unit dedicated to the observation, care and treatment of patients with life threatening illnesses, injuries or complications from which recovery is generally possible. An intensive care unit (ICU) provides special expertise and facilities with the aim to restore vital organ function to normal in order to gain time to treat an underlying cause.

### Principles

1. Critically ill patients with **reversible** medical conditions with a **reasonable** prospect of **meaningful** recovery should be admitted to an ICU. In the event of unavailability of ICU beds in the hospital, an ICU bed should be sourced from another neighbouring hospital.
2. Priority of admission shall be based on the urgency of patient's need for intensive care.
3. Withdrawal of therapy is advocated when continuing intensive care is deemed medically futile.
4. Triaging is the strategy used to select patients for admission when unit capacity is reached.

### Admission Policy

- a. It is the responsibility of the patient's attending clinician to request for ICU admission.
- b. It is the responsibility of the ICU specialist to decide if a patient meets eligibility requirements for ICU (refer to admission criteria for ICU).



# Admission and Discharge Policy in the Intensive Care Unit

## Admission Policy

- c. Admission from the Emergency and Trauma Department or from another hospital must have a primary care unit. While in ICU, these patients shall remain under the primary team. Transfer of care to a different unit must be arranged by the primary unit.
- d. Admission from other hospitals must be liaised with the ICU specialist before transfer of the patient.
- e. Resuscitation for life-threatening condition must be continued pending ICU admission.
- f. The following factors should be taken into consideration in triaging:
  - Diagnosis
  - Severity of illness
  - Age and functional status
  - Co-morbid disease
  - Physiological reserve
  - Prognosis
  - Availability of suitable treatment
  - Response to treatment to date
  - Recent cardiopulmonary arrest
  - Anticipated quality of life

## Discharge Policy

- a. It is the responsibility of the ICU specialist to decide if a patient is to be discharged (refer to appendix 1 for discharge criteria). Patients are discharged when the reason for admission has resolved.
- b. It is the responsibility of the primary team to promptly receive patients who are discharged from ICU and the primary team must be informed of all potential or continuing problems.
- c. The Acute Pain Team should be notified if patients under their care are discharged.
- d. If appropriate, limitation/non-escalation of treatment must be clearly documented prior to discharge.
- e. A discharge summary must be completed in the case notes prior to discharge.



# Admission and Discharge Policy in the Intensive Care Unit

## Appendix 1 Admission and Discharge Criteria

### Admission Criteria

- I. Patients with the following conditions are candidates for admission to the general ICU. The following conditions include, but are not limited to:

**A. Respiratory**

1. Acute respiratory failure requiring ventilatory support
2. Acute pulmonary embolism with haemodynamic instability
3. Massive haemoptysis
4. Upper airway obstruction

**B. Cardiovascular**

1. Shock states
2. Life-threatening dysrhythmias
3. Dissecting aortic aneurysms
4. Hypertensive emergencies
5. Need for continuous invasive monitoring of cardiovascular system (arterial pressure, central venous pressure, cardiac output)

**C. Neurological**

1. Severe head trauma
2. Acute spinal cord injury
3. Status epilepticus
4. Meningitis with altered mental status or respiratory compromise
5. Acutely altered sensorium with the potential for airway compromise
6. Progressive neuromuscular dysfunction requiring respiratory support and / or cardiovascular monitoring (myasthenia gravis, Guillain-Barre syndrome)
7. Brain dead or potentially brain dead patients who are being aggressively managed while determining organ donation status

**D. Renal**

1. Requirement for acute renal replacement therapies in an unstable patient
2. Acute rhabdomyolysis with renal insufficiency



## Admission and Discharge Policy in the Intensive Care Unit

<b>E.</b>	<b>Endocrine</b>	<ol style="list-style-type: none"><li>1. Diabetic ketoacidosis complicated by haemodynamic instability, altered mental status</li><li>2. Hyperosmolar hyperglycemic state</li><li>3. Thyroid storm or myxedema coma with haemodynamic instability</li><li>4. Hyperosmolar state with coma and/or haemodynamic instability</li><li>5. Adrenal crises with haemodynamic instability</li><li>6. Other severe electrolyte abnormalities, such as:<ul style="list-style-type: none"><li>- Hypo or hyperkalemia with dysrhythmias or muscular weakness</li><li>- Severe hypo or hyponatremia with seizures, altered mental status</li><li>- Severe hypercalcemia with altered mental status, requiring haemodynamic monitoring</li></ul></li></ol>
<b>F.</b>	<b>Gastrointestinal</b>	<ol style="list-style-type: none"><li>1. Life threatening gastrointestinal bleeding</li><li>2. Acute hepatic failure leading to coma, haemodynamic instability</li><li>3. Severe acute pancreatitis</li></ol>
<b>G.</b>	<b>Haematology</b>	<ol style="list-style-type: none"><li>1. Severe coagulopathy and/or bleeding diathesis</li><li>2. Severe anemia resulting in haemodynamic and/or respiratory compromise</li><li>3. Severe complications of sickle cell crisis</li><li>4. Haematological malignancies with multi-organ failure</li></ol>
<b>H.</b>	<b>Obstetric</b>	<ol style="list-style-type: none"><li>1. Medical conditions complicating pregnancy</li><li>2. Severe pregnancy induced hypertension/eclampsia</li><li>3. Obstetric haemorrhage</li><li>4. Amniotic fluid embolism</li></ol>
<b>I.</b>	<b>Multi-system</b>	<ol style="list-style-type: none"><li>1. Severe sepsis or septic shock</li><li>2. Multi-organ dysfunction syndrome</li><li>3. Polytrauma</li><li>4. Dengue haemorrhagic fever/dengue shock syndrome</li><li>5. Drug overdose, poisoning and adverse drug reactions with potential acute decompensation of major organ systems</li></ol>



# Admission and Discharge Policy in the Intensive Care Unit

		<ul style="list-style-type: none"><li>6. Environmental injuries (lightning, near drowning, hypo/hyperthermia)</li><li>7. Severe burns</li></ul>
J.	<b>Surgical</b>	<ul style="list-style-type: none"><li>1. High risk patients in the peri-operative period</li><li>2. Post-operative patients requiring continuous haemodynamic monitoring/ ventilatory support, usually following:<ul style="list-style-type: none"><li>- vascular surgery</li><li>- thoracic surgery</li><li>- airway surgery</li><li>- craniofacial surgery</li><li>- major orthopaedic and spine surgery</li><li>- general surgery with major blood loss/ fluid shift</li><li>- neurosurgical procedures</li></ul></li></ul>

## II. Patients who are generally not appropriate for ICU admission

- A. Irreversible brain damage
- B. End stage cardiac, respiratory and liver disease with no options for transplant
- C. Metastatic cancer unresponsive to chemotherapy and/or radiotherapy
- D. Patients with non-traumatic coma leading to a persistent vegetative state
- E. Severe disability with poor quality of life

## Discharge Criteria

Discharge will be based on the following criteria:

- 1. Stable haemodynamic parameters
- 2. Stable respiratory status and patent airway
- 3. Oxygen requirements not more than 60%
- 4. Intravenous inotropic/vasopressor support and vasodilators are no longer necessary. Patients on low dose inotropic support may be discharged earlier if ICU bed is required.
- 5. Cardiac dysrhythmias are controlled
- 6. Neurologic stability with control of seizures
- 7. Patients who require chronic mechanical ventilation (eg motor neuron disease, cervical spine injuries) with the acute critical problems improved



## Admission and Discharge Policy in the Intensive Care Unit

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# Investigations and Microbiological Surveillance in the Intensive Care Unit

Laboratory and radiological investigations are done to guide clinical management of the patients. Some investigations may be ordered on a routine basis to facilitate the overall daily management of the unit.

### *Basic investigations on admission*

- Full blood count (FBC)
- Serum creatinine, blood urea and electrolytes (BUSE) including  $\text{Na}^+$ ,  $\text{K}^+$ ,  $\text{Cl}^-$ ,  $\text{Ca}^{2+}$ ,  $\text{Mg}^{2+}$ ,  $\text{PO}_4^{3-}$
- Liver function test (LFT)
- Prothrombin time (PT), activated partial thromboplastin time (APTT)
- Arterial blood gas
- Blood glucose or point of care blood glucose level

### *Additional tests on admission when indicated*

- In patients with suspected sepsis, relevant cultures/serology and septic biomarkers eg C-reactive protein, lactate should be sent.
- There is no role for routine Chest X ray (CXR) on admission. However CXR should be ordered following placement of central venous catheter, endotracheal tube, nasogastric tube, chest drains or when cardiorespiratory pathology is suspected.
- ECG, Cardiac enzymes (Creatine Kinase, Creatine Kinase -MB, Lactate Dehydrogenase, Aspartate Transaminase, Troponin T) for suspected coronary syndromes and arrhythmias.

### *Investigations after admission when indicated*

- Daily FBC
- Daily BUSE, creatinine
- Biweekly LFT, Calcium, Magnesium and Phosphate
- Biweekly PT/APTT
- Other tests only when indicated (including CXR in the mechanically ventilated patients)



# Investigations and Microbiological Surveillance in the Intensive Care Unit

## *Microbiological Surveillance*

1. Current evidence does not support the use of routine active surveillance cultures for the detection of methicillin - resistant *Staphylococcus aureus* (MRSA). However in an MRSA outbreak, there is strong evidence for active surveillance cultures. Nasal swabs are taken from all ICU patients, wound swabs taken when applicable and nasal swabs from staff only if implicated in transmission.
2. In an vancomycin-resistant enterococci (VRE) outbreak, surveillance swabs should include rectal swabs from all ICU patients, wound swabs in applicable patients and rectal swabs from staff only if implicated in transmission.
3. For multidrug- resistant gram- negative bacilli (MDR- GNB) e.g. Extended Spectrum Beta-lactamases (ESBLs), multidrug- resistant *Acinetobacter baumannii*, multidrug-resistant *Pseudomonas aeruginosa*, carbapenem-resistant enterobacteriaceae (CRE), active surveillance cultures have been used as part of efforts to successful control of MDR-GNB in outbreak settings. In the setting of a respiratory reservoir outbreak, tracheal aspirate culture should be sent from suspected patients.
4. In the case of CRE, experience with other multidrug-resistant organisms (MDROs) suggests that it might be most effective to intervene on emerging MDROs when they are first recognized in a facility before they become common. For this reason facilities that rarely (e.g. < 1 per month) or never have patients admitted who are colonized or infected with CRE should be aggressive about controlling these organisms when they are identified. Screen epidemiologically-linked patient contacts (e.g., roommates) for CRE with at least stool, rectal, or peri-rectal cultures and sometimes cultures of wounds or urine (if a urinary catheter is present). Consider point prevalence survey of affected unit. During an outbreak, screening cultures of contacts are also important.
5. Surveillance cultures for endotracheal aspirates may be done weekly to
  - identify MDR pathogens
  - predict susceptibility patterns
  - aid empiric antibiotic therapy



# Investigations and Microbiological Surveillance in the Intensive Care Unit

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11. CDC. Guidance for Control of Carbapenem-resistant Enterobacteriaceae (CRE). 2012 CRE Toolkit

## Ventilatory Strategies in Severe Hypoxemic Respiratory Failure

### Introduction

The primary aim in treatment of hypoxemic respiratory failure is maintenance of adequate oxygenation, while limiting ventilator-induced lung injury and oxygen toxicity.

$P_{aO_2}/F_{iO_2}$  ratio remains the most convenient and widely used bedside index of oxygen exchange. Another measure of oxygenation is alveolar-arterial oxygen gradient (A-a gradient) and its equation can be simplified as  $A-a \text{ gradient} = [(7 \times F_{iO_2} \times 100) - P_{aCO_2}] - P_{aO_2}$ . In a ventilated patient, oxygenation index (OI) incorporates the severity of oxygenation impairment ( $P_{aO_2}/F_{iO_2}$  ratio) and mean airway pressure ( $mP_{aw}$ ) into a single variable, where  $OI = mP_{aw} \times F_{iO_2} \times 100 / P_{aO_2}$ . OI of  $> 30$  is often used to represent failure of conventional ventilation.

### Principles

1. There is no evidence that a particular mode of mechanical ventilation is associated with survival benefit.
2. Choosing appropriate goals for mechanical ventilation is more important than the mode.
3. Low tidal volume ventilation should be instituted in all patients on mechanical ventilation. Target tidal volume of 6 ml/kg ideal body weight (IBW) and plateau pressure ( $P_{plat}$ ) of  $< 30$  cmH<sub>2</sub>O.
4. If necessary, accept physiologic target outside normal range e.g. permissive hypoxemia and permissive hypercapnia.
5. The optimal time to initiate ventilatory rescue therapies in high potential recruiters is within 96 hours of onset of Acute Respiratory Distress Syndrome (ARDS) when alveolar recruitment potential is the greatest.
6. The choice of rescue therapy should be based on equipment availability and clinician expertise. If the therapy does not result in improved oxygenation, it should be abandoned.



# Ventilatory Strategies in Severe Hypoxemic Respiratory Failure

## *Low tidal volume ventilation*

1. Calculate ideal body weight (IBW) of the patient  
Male =  $50 + 0.91 [\text{height (cm)} - 152.4]$  kg  
Female =  $45.5 + 0.91 [\text{height (cm)} - 152.4]$  kg
2. Mode: Pressure-controlled ventilation (PCV) or volume-controlled ventilation (VCV)
3. Aim for tidal volume of 6 ml/kg IBW while not exceeding  $P_{\text{plat}}$  of 30 cmH<sub>2</sub>O. In PCV,  $P_{\text{plat}}$  is equivalent to peak airway pressure. If VCV is used, the  $P_{\text{plat}}$  needs to be measured regularly e.g. q2–4 h.
4. If  $P_{\text{plat}} > 30$  cmH<sub>2</sub>O, decrease tidal volume by 1 ml/kg to 5 ml/kg or if necessary to 4 ml/kg. If severe dyspnoea occurs, tidal volume may be increased to 7 or 8 ml/kg if  $P_{\text{plat}}$  remains  $\leq 30$  cmH<sub>2</sub>O.
5. Use the lowest  $F_{\text{iO}_2}$  to achieve adequate oxygenation. Accept  $P_{\text{aO}_2}$  55–80 mmHg or  $S_{\text{pO}_2}$  88–95%.
6. Aim arterial pH  $> 7.1$ . The respiratory rate may be increased to a maximum of 35/min. Infusion of intravenous NaHCO<sub>3</sub> 8.4% at 10–20 ml/hr may be considered. Contraindications to permissive hypercapnia include intracranial hypertension, concomitant metabolic acidosis, acute coronary syndrome, right heart failure and worsening pulmonary hypertension.

## *Strategies to improve severe hypoxemia*

1. If conventional ventilation fails (i.e.  $\text{OI} > 30$ ) to improve oxygenation, firstly evaluate the recruitment potential of the lungs.
2. The potential for lung recruitment can be identified by the use of a 30 minutes' trial of increased positive end expiratory pressure (PEEP) at 15 cmH<sub>2</sub>O. High potential recruiters are those who at the end of the trial demonstrate all of the following:
  - a) increase in  $P_{\text{aO}_2}/F_{\text{iO}_2}$
  - b) decrease in  $P_{\text{aCO}_2}$
  - c) increase in compliance
3. Subsequent ventilatory approach is based on the distinction between patients who are low potential recruiters (non-recruiters) and high potential recruiters (recruiters).



## Ventilatory Strategies in Severe Hypoxemic Respiratory Failure

4. Do not perform further recruitment manoeuvres in non-recruiters. PEEP should not be set more than 10 cmH<sub>2</sub>O in these patients. Consider non-ventilatory strategies to improve PaO<sub>2</sub>.
5. The following steps are to be performed only in recruiters:
  - i. Perform recruitment manoeuvre. Additional sedation, paralysis or both may be required during manoeuvre. Monitor for hypotension and desaturation.
  - ii. Different lung recruitment manoeuvres that may be performed are:
    - a) Sustained high pressure inflation
      - CPAP 30 - 50 cmH<sub>2</sub>O for 20 - 40 s
    - b) PCV with PEEP of 25 - 30 cmH<sub>2</sub>O, PIP of 40 - 45 cmH<sub>2</sub>O for 2 min
    - c) PCV with stepwise increase in PEEP every 2 min, keeping the driving pressure constant, up to PIP of 45 - 50 cmH<sub>2</sub>O

An alternative method is a stepwise increase in PEEP with return to baseline between each increase (refer algorithm 1).

- PCV with driving pressure 15 cmH<sub>2</sub>O, RR 10/min, I:E 1:1, FiO<sub>2</sub> 1.0.
  - Start with PEEP 20 cmH<sub>2</sub>O.
  - PEEP is increased by 5 cmH<sub>2</sub>O every 2 min until PIP of 45 - 50 cmH<sub>2</sub>O and PEEP 30 - 35 cmH<sub>2</sub>O
- iii. At the end of the recruitment manoeuvre, perform ABG at FiO<sub>2</sub> 1.0.  
PaO<sub>2</sub> + PaCO<sub>2</sub> > 400 mmHg suggests that there is less than 5% of alveolar collapse.  
If PaO<sub>2</sub> + PaCO<sub>2</sub> < 400 mmHg, consider repeating recruitment manoeuvre.
  - iv. Determine the optimal PEEP using the decremental PEEP technique.  
Set PEEP at 20 cmH<sub>2</sub>O and reduce the PEEP in a stepwise fashion (1 cm H<sub>2</sub>O every 5 min) until derecruitment occurs as demonstrated by a decrease in PaO<sub>2</sub> (a reduction of more than 10% from the previous indicates the collapse pressure) and decrease in compliance.

The optimal PEEP is set at 2 cmH<sub>2</sub>O above the collapse pressure.  
Re-recruit the lung at the optimal PEEP level.

- v. Reassess in recruiters.  
If PaO<sub>2</sub>/FiO<sub>2</sub> < 60, consider rescue therapy e.g. HFOV  
If PaO<sub>2</sub>/FiO<sub>2</sub> is 60 -100, consider APRV/ HFOV



## Ventilatory Strategies in Severe Hypoxemic Respiratory Failure

### 6. Non-ventilatory rescue strategies to improve oxygenation:

#### a) Neuromuscular blockers

Given the risk of myopathy, clinically significant improvement in oxygenation must be demonstrated with a single dose prior to committing to continuous infusion.

#### b) Prone positioning

May be considered in patients with ARDS requiring  $F_iO_2 > 0.6$  or elevated plateau-pressure  $> 30$  cmH<sub>2</sub>O.

Possible complications include pressure ulcers, unplanned extubation, dislodgement of catheters, increased use of sedatives.

#### c) Moderate dose glucocorticoids

May be considered in patients with:

- early (within 72h of diagnosis), severe ARDS ( $P_aO_2/F_iO_2 < 200$ )
- unresolving ARDS before D14

The role of steroids in less severe cases,  $P_aO_2/F_iO_2 > 200$  mmHg, is less clear.

A regime using methylprednisolone for 28 days is as follows:

Loading dose intravenous 1 mg/kg followed by infusion:

- 1 mg/kg/day D1 - D14
- 0.5 mg/kg/day D15 - 21
- 0.25 mg/kg/day D22 - D25
- 0.125 mg/kg/day D26 - D28

Change to single oral dose when enteral intake is restored.

If extubated between D1 - D14, proceed to D15 of therapy.

### 7. Other non-ventilatory strategies to improve oxygenation:

#### a) Avoid drugs that inhibit hypoxic pulmonary vasoconstriction e.g. nitrates, calcium channel blockers, dobutamine and dopamine.

#### b) Conservative fluid management with or without frusemide may improve oxygenation. Exercise caution in patients who are hypovolemic.

#### c) Albumin 20% with frusemide may be considered in patients who are hypoproteinemic (serum protein $< 50$ g/L)

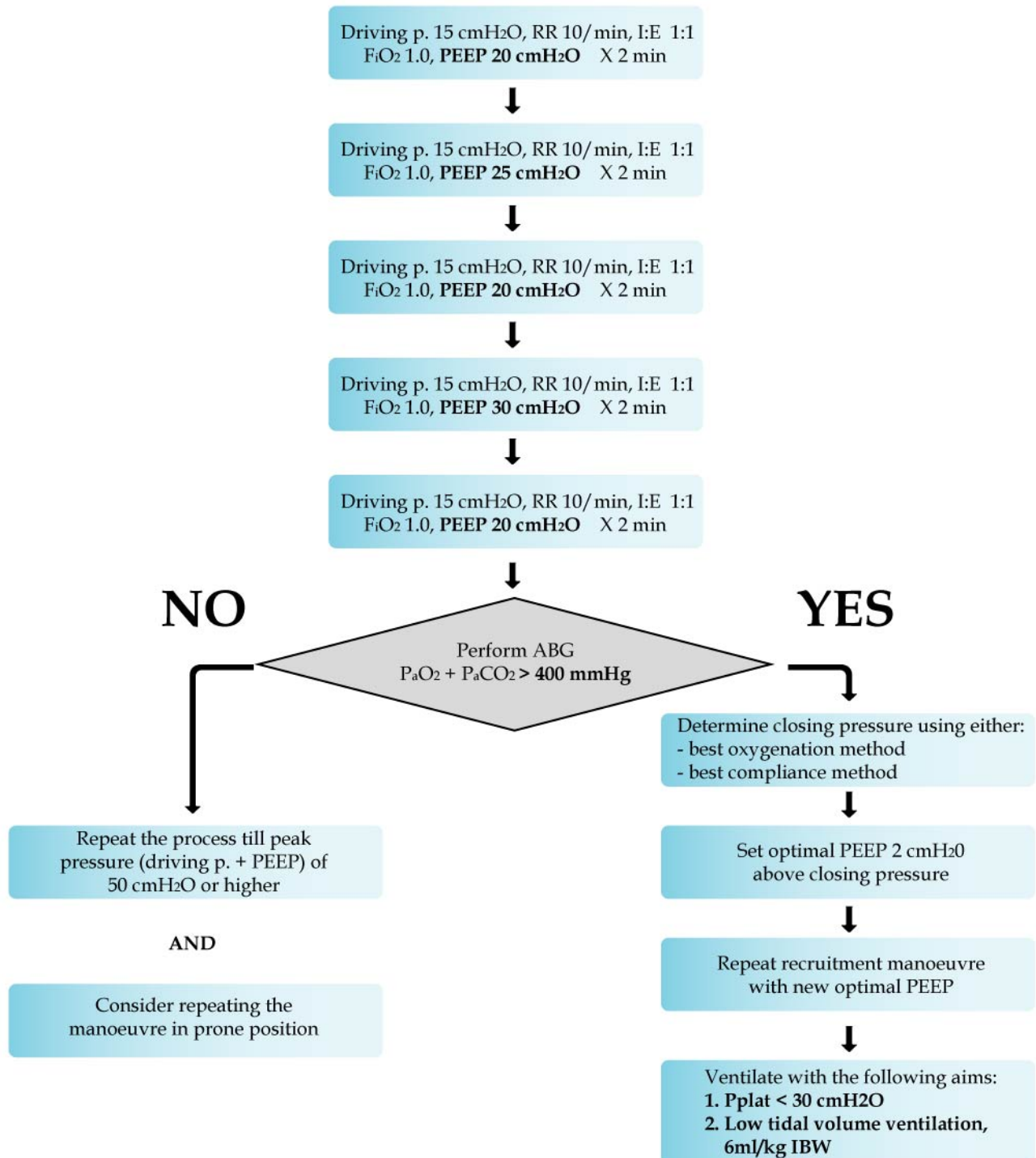
A regime described is as follows:

- 25g IV albumin over 1.5 - 2h q8h with continuous infusion of frusemide X 5 days
- IV frusemide is titrated every q8h to achieve a daily weight loss  $\geq 1$  kg/day

# Ventilatory Strategies in Severe Hypoxemic Respiratory Failure

## Algorithm 1:

*Lung recruitment manoeuvre using the PCV step-wise incremental PEEP with return to baseline method*





# Ventilatory Strategies in Severe Hypoxemic Respiratory Failure

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# Weaning from Mechanical Ventilation in the Intensive Care Unit

### Introduction

Weaning is the process of gradual withdrawal of mechanical ventilation. The process is uneventful in most patients, but may take up half the time on a ventilator in problematic patients.

### Principles

1. Most patients require a period of rest after intubation, but consideration of the weaning process should begin very soon after intubation.
2. The cause of the patient's initial respiratory failure must be significantly improved or resolved before consideration of readiness to wean.
3. Evaluation of readiness to wean should be started EARLY and repeated at least on a daily basis. Delay in clinical judgment that weaning may be possible and delay in assessment of readiness to wean is a common cause of delayed weaning.
4. The patient must be awake, cooperative, haemodynamically stable and able to cough and protect airway before extubation.
5. It is important to minimize or discontinue sedation for daytime breathing trials.
6. Unless there is evidence for clearly irreversible disease (e.g. high spinal cord injury, advanced amyotrophic lateral sclerosis), a patient requiring prolonged mechanical ventilatory support for respiratory failure should not be considered permanently ventilator dependent until 3 months of failed weaning attempts.

### Assessment of readiness to wean – clinical and objective measures

Clinical assessment:

- Resolution of acute phase of disease for which patient was intubated
- Adequate cough
- Absence of excessive tracheobronchial secretions



# Weaning from Mechanical Ventilation in the Intensive Care Unit

## *Objective measures:*

1. Respiratory criteria
  - i. Adequate oxygenation:  $\text{PaO}_2 \geq 60$  mmHg on  $\text{FiO}_2 \leq 0.5$  and  $\text{PEEP} \leq 8$  cmH<sub>2</sub>O
  - ii. No significant respiratory acidosis: pH and  $\text{PaCO}_2$  appropriate for patient's base-line respiratory status
  - iii. Respiratory rate (RR) < 35 breaths/min
  - iv. Tidal volume > 5 ml/kg
  - v. Minute volume < 12L/min
2. Cardiovascular criteria
  - i. Heart rate < 140/min
  - ii. Blood pressure (BP) normal with minimal or no vasopressor support (eg dopamine < 5 mcg/kg/min)
  - iii. No evidence of myocardial ischemia
3. Neurological criteria
  - i. Patient is arousable or Glasgow Coma Score (GCS)  $\geq 13$



### *Note:*

*None of these measurements, when used in isolation, can predict with certainty which patients are ready to breathe spontaneously independently. However, when taken together, these measurements provide an impression of how difficult it will be for the patient to resume spontaneous breathing.*

*Once the patient is deemed ready to wean, proceed with spontaneous breathing trial. It is important to communicate with the patient that attempt at discontinuation of ventilation is about to begin.*

## *Spontaneous breathing trial (SBT)*

The SBT can be conducted while the patient is still connected to the ventilator circuit or the patient can be removed from the ventilator and allowed to breathe through an independent source of oxygen via a T-shaped breathing circuit (known as the T-piece).

1. SBT through the ventilator:
  - i. Use pressure support (PS) ventilation of 5-7 cmH<sub>2</sub>O + low level PEEP (5 cmH<sub>2</sub>O).
  - ii. The advantage is patient safety as patient is not disconnected from ventilator and back-up ventilation can be provided if the patient is apnoeic. In addition, tidal volume and respiratory rate can be monitored.



## Weaning from Mechanical Ventilation in the Intensive Care Unit

2. SBT through a T-piece:
  - i. Deliver oxygen-enriched gas at high flow rates (greater than the patient's inspiratory flow rate) through the horizontal arm of the T-shaped circuit.
  - ii. The advantage is the reduced work of breathing with the T-shaped circuit.

### *Protocol for SBT*

1. Allow 30 to 120 minutes for the initial trial of spontaneous breathing.
2. Increase the  $F_iO_2$  by 10% for the period of spontaneous breathing.
3. For cases of short-term ventilatory support (eg post major surgery), a successful one-hour (1h) of spontaneous breathing is enough to discontinue ventilation.
4. For cases of prolonged mechanical ventilation (> 1 week), a longer period (at least 8h and sometimes up to 24h) of spontaneous breathing is needed before discontinuing ventilation.
5. SBT is considered a failure when patient develops respiratory, cardiovascular or neurological instability.

### *Criteria for passing spontaneous breathing trial:*

- Rapid shallow breathing index (rate/expiratory tidal volume ratio) < 100 breaths/min/L
- Gas exchange acceptable:  $PaO_2 \geq 60$  mmHg &  $SaO_2 \geq 90\%$  on  $F_iO_2 \leq 0.5$   
 $pH \geq 7.32$   
Increase in  $PaCO_2 < 10$  mmHg
- Stable respiratory rate: RR < 35 breaths/min or increase < 50%
- Haemodynamically stable: Heart rate < 120/min or increase < 20%  
Systolic BP > 90 mmHg & < 180 mmHg or increase < 20%  
No significant cardiac arrhythmias
- No agitation or anxiety
- No significant change in mental status
- No diaphoresis or signs of increased work of breathing (accessory muscle use, dyspnoea, paradoxical abdominal breathing)



# Weaning from Mechanical Ventilation in the Intensive Care Unit

## *Extubation*

Before extubation, assess patient's ability to protect and maintain airway:

1. Level of consciousness
2. Cough strength - usually subjective assessment
3. Quantity of secretions, frequency of suctioning – likelihood of successful extubation decreases with increased secretions and frequent suction intervals
4. Airway patency – cuff leak test (patients with prolonged intubation, or difficult / traumatic intubation are at risk for post-extubation upper airway obstruction). Refer to appendix 1 for explanation of cuff leak test.

## *Approach to difficult-to-wean patients / weaning failure*

1. Definition of weaning failure – any one of:
  - Failure of SBT
  - Reintubation / resumption of ventilator support within 48h
  - Death within 48h of extubation
2. Provide ventilatory management which balances need for adequate ventilatory support (minimizing respiratory fatigue) against need to minimize support (increasing patient's respiratory autonomy).
3. If a patient fails a SBT:
  - Increase ventilator settings to previously tolerated level or higher if necessary until patient stable again and wait 24h before trying again
  - Search thoroughly and systematically for potentially reversible aetiologies (see appendix 2)
  - Use PS ventilation as a weaning tool by gradually reducing the PS by 2 cmH<sub>2</sub>O once or twice a day as tolerated
  - Once the PS is reduced to a minimal level (eg 10 cmH<sub>2</sub>O), repeat SBT daily until the patient can be successfully extubated
4. Concept of nocturnal rest in conjunction with daytime respiratory muscle training is important for difficult or prolonged weaning patients.



# Weaning from Mechanical Ventilation in the Intensive Care Unit

## *Role of Non-invasive Ventilation (NIV) in weaning*

1. NIV can be used as an alternative weaning technique in patients who have failed conventional weaning or failed to meet standard extubation criteria.
  - Rationale: to facilitate earlier removal of endotracheal tube while still allowing a progressive stepwise reduction of ventilator support.
  - Involves extubating the patient who has failed a SBT directly onto NIV (PS + CPAP) - ONLY in patients with good airway protection, strong cough and minimal secretions.
  - In practice, this use of NIV is mainly for facilitating weaning in stable chronic obstructive pulmonary disease (COPD) patients.
2. Prophylactic measure in patients with high risk for reintubation
  - NIV can be used prophylactically to reduce reintubation rate in CAREFULLY SELECTED high risk patients ie certain post-operative patients (abdominal or vascular surgery).



### *Note:*

*NIV should only be used in centres where staff has the relevant training, expertise and experience to do so.*

## *Role of Tracheostomy*

- Must be considered:
  - i. in any patient deemed difficult to wean (patients who fail initial SBT and require up to 3 SBTs or up to 7 days to pass a SBT)
  - ii. certainly in all patients with prolonged wean (patients who fail at least 3 SBTs or require more than 7 days to pass a SBT)
- Potential benefits: less sedative requirement, more secure airway, reduction in oropharyngeal trauma, prevention of ventilator-associated pneumonia, reduction in work of breathing, earlier transition to oral feeding, improved patient comfort and communication
- Very little evidence to guide optimal timing for a tracheostomy; studies have not determined whether early or late tracheostomy is superior.



# Weaning from Mechanical Ventilation in the Intensive Care Unit

## *Protocol to wean a tracheostomised patient with prolonged wean or prolonged mechanical ventilation*

- Principle is to utilize daily SBTs of progressively increasing duration after a certain level of ventilatory support reduction has occurred.
- Firstly, reduce level of PS gradually (by 2 cmH<sub>2</sub>O q12- 24h).
- Once a PS of 10 - 12 cmH<sub>2</sub>O is reached, perform assessment for readiness to wean.
- If deemed ready to wean, perform SBT using a trachymask for eg 2h.
- After completing SBT, connect back to ventilator using PS ventilation mode with at least PS 10 cmH<sub>2</sub>O.
- Perform daily SBT via trachymask and progressively increase duration of SBT (eg 2h, 4h, 6h, 8h etc).
- If at the end of a SBT, the patient feels comfortable and wishes to continue, SBT duration may be lengthened.
- Eventual goal is to reach 24h without ventilator support and therefore be completely liberated from ventilator.

## Appendix 1 Cuff Leak Test

1.	<b>Qualitative assessment</b>	Deflate cuff and listen for air movement around ETT using stethoscope placed over upper trachea.
2.	<b>Quantitative assessment</b>	<p>Change to volume-cycled ventilation, then deflate cuff. Measure the difference between inspired and expired tidal volumes.</p> <p>Average the lowest 3 tidal volumes over 6 breaths, and subtract that from the inspired tidal volume --&gt; gives you the cuff leak volume (CLV).</p> <p>CLV &lt; 110 ml or &lt; 12-24% of delivered tidal volume is the threshold for determination of a diminished airway patency.</p>
3.		<p>To improve prediction of post-extubation stridor, perform simultaneous assessment of cough and cuff leak:</p> <p>Deflate cuff, occlude ETT and instruct patient to cough.</p> <p>Absence of both audible cough and cuff leak indicates patient is 10 times more likely to develop post-extubation stridor.</p>



# Weaning from Mechanical Ventilation in the Intensive Care Unit

## Appendix 2 Causes of failed SBT / weaning failure

### 1. Cardiac dysfunction

- i. Ischaemic heart disease
- ii. Valvular heart disease
- iii. Systolic or diastolic dysfunction
- iv. Increased metabolic demand of weaning imposing an increased cardiac workload
- v. Dynamic hyperinflation

### 2. Respiratory dysfunction

- I. Reduced pulmonary compliance
  - i. Pneumonia (primary admission diagnosis or ventilator-associated)
  - ii. Cardiogenic or non-cardiogenic pulmonary oedema
  - iii. Pulmonary fibrosis
  - iv. Pulmonary haemorrhage
  - v. Reduced chest wall compliance eg kyphocoliosis
  - vi. Splinting eg abdominal distension, obesity and ascites
- II. Obstructive problems
  - i. Bronchoconstriction
  - ii. Tube obstruction
  - iii. Kinked tube
  - iv. Inappropriate ventilator settings resulting in increased work of breathing
  - v. (Post-extubation) – glottic oedema, increased airway secretions, sputum retention

### 3. Neuromuscular

- I. Depressed central drive
  - i. Encephalitis
  - ii. Brainstem haemorrhage/ischaemia
  - iii. Sedative/hypnotic medications
  - iv. Metabolic alkalosis
- II. Peripheral nervous system dysfunction
  - i. Guillain-Barre syndrome, myasthenia gravis (usually apparent before weaning)
  - ii. Critical illness neuromuscular abnormalities (important cause!)

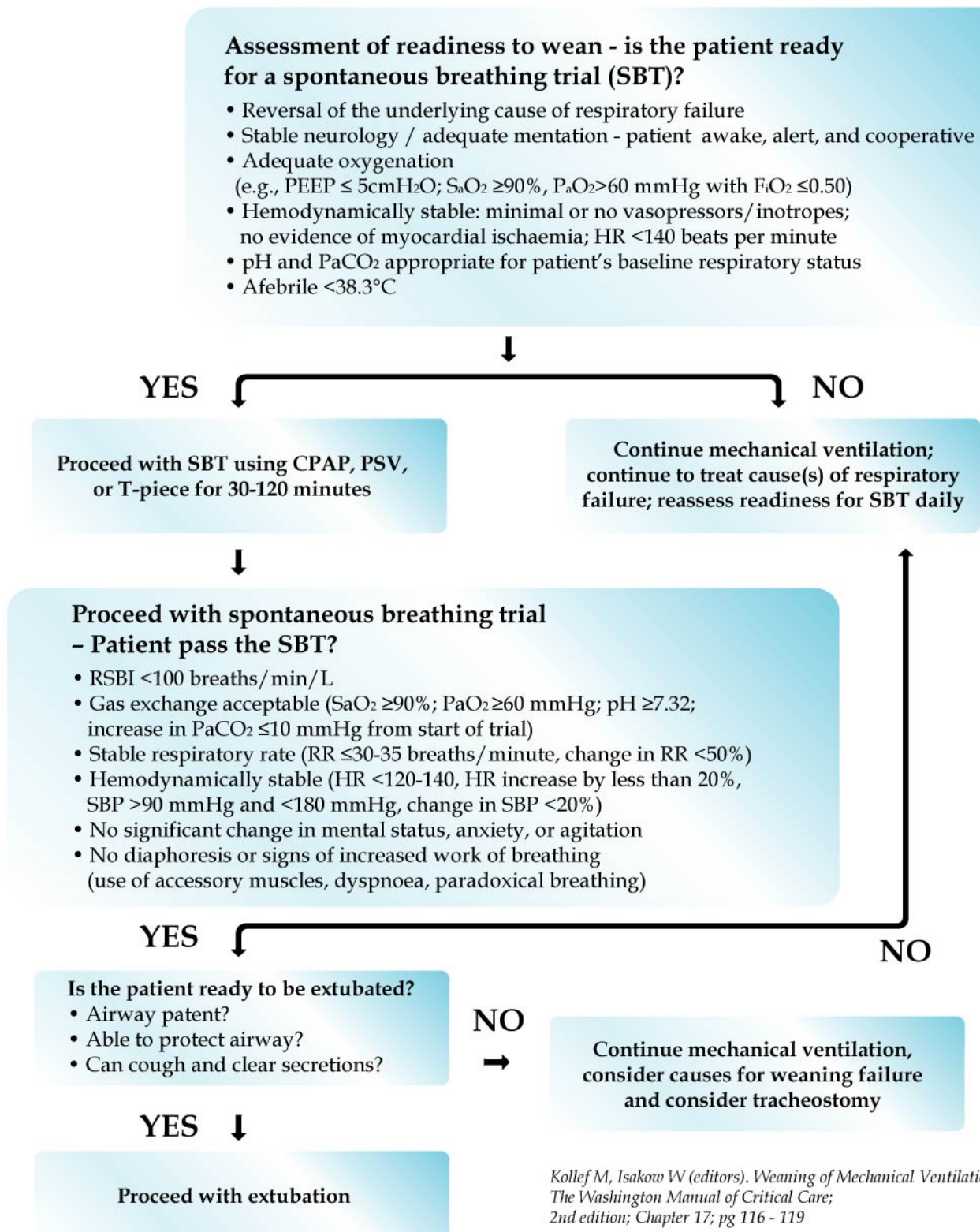


## Weaning from Mechanical Ventilation in the Intensive Care Unit

4. **Nutrition**
  - i. Obesity
  - ii. Malnutrition
  - iii. Overfeeding
5. **Unresolved systemic disease - sepsis**
6. **Neuropsychological**
  - i. Delirium
  - ii. Depression
  - iii. Anxiety
7. **Metabolic**
  - i. Hypokalaemia, hypomagnesemia, hypophosphatemia
  - ii. Steroids and hyperglycaemia – controversial
8. **Anaemia (Controversial)**

# Weaning from Mechanical Ventilation in the Intensive Care Unit

## Algorithm 1: Weaning





## Weaning from Mechanical Ventilation in the Intensive Care Unit

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## Inotropic and Vasopressor Support in Intensive Care

### Introduction

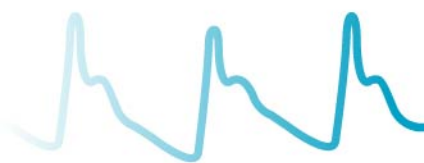
The treatment aim in patients with hypotension and inadequate tissue perfusion is to maintain a perfusion pressure necessary for tissue oxygenation. Identify type of shock whether it is obstructive, distributive, hypovolemic, cardiogenic or mixed.

### Principles

1. Before the use of inotropic and vasopressor support, it is important to:
  - i. Correct hypovolemia
  - ii. Exclude causes of obstructive shock eg. tension pneumothorax, cardiac tamponade and pulmonary embolism
2. The selection of the drugs is determined by the cause of shock and the desired therapeutic activity targeting the underlying pathophysiology.
3. The dose of inotropes and vasopressors need to be titrated to targeted goals.
4. The route of administration of inotropes and vasopressors is via central venous catheter.
5. Blood pressure shall be monitored continuously via arterial line.
6. Advanced hemodynamic studies e.g cardiac output monitoring may be necessary in some groups of patient with refractory shock.

### Inotropic and vasopressor support in septic shock

Septic shock is defined as sepsis-induced hypotension persisting despite adequate fluid resuscitation, together with evidence of tissue hypoperfusion (i.e altered mental status, elevated lactate and oliguria). Resuscitation should be commenced immediately in patients with hypotension or elevated serum lactate > 4mmol/l. Do not delay resuscitation pending ICU admission.



## Inotropic and Vasopressor Support in Intensive Care

The following goals are recommended:

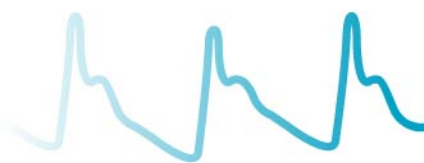
- Target mean arterial pressure (MAP)  $\geq 65$ ; higher value is recommended in hypertensive or renal impaired patient
- Assess fluid responsiveness
- Aim to achieve urine output  $> 0.5 \text{ ml/kg/hr}$
- Aim for  $\text{ScvO}_2 \geq 70\%$

Fluid responsiveness can be measured by static or dynamic parameters.

- Static parameters such as central venous pressure (CVP) and pulmonary artery occlusion pressure (PAOP) have been shown to be poor indicators of patient's fluid status and fluid responsiveness.
- Dynamic parameters are pulse pressure variation (PPV) and stroke volume variation (SVV). Use of PPV and SVV in mechanically ventilated (tidal volume  $\geq 8 \text{ ml/kg}$ ) patients with no or minimal spontaneous breathing can discriminate between fluid responders and non responders. PPV  $> 13\%$  and SVV  $> 10\%$  indicate fluid responsiveness and more fluid may be given.
- Utilize passive leg raising test (PLR) together with PPV or SVV to detect fluid responsiveness in spontaneously breathing patients (see figure 1)

The initial vasopressor of choice is noradrenaline.

1. Commence IV noradrenaline infusion
  - Dose  $0.02\text{-}1.5 \text{ mcg/kg/min}$
2. IV dopamine or adrenaline can be added if blood pressure is poorly responsive to IV noradrenaline
  - Dopamine dose  $3\text{-}20 \text{ mcg/kg/min}$
  - Adrenaline dose  $1\text{-}20 \text{ mcg/min}$
  - Caution: Adrenaline may worsen acidosis and increase lactate.  
Dopamine may cause cardiac arrhythmias and should be used in patients with low risk of dysrhythmias.
3. Consider adding IV hydrocortisone  $50 \text{ mg q6h}$  or  $100 \text{ mg q8h}$  in refractory shock



## Inotropic and Vasopressor Support in Intensive Care

4. Add IV vasopressin infusion if MAP is still below 65 mmHg (20 units diluted in 20 ml 0.9% NS or D5%)
  - Dose 0.01-0.04 units/min
  - Doses up to 0.067 units/min can be used in refractory shock
  - Add iv hydrocortisone if remains hypotensive and not yet on steroids

Caution: In low cardiac output state, vasopressin may further decrease cardiac output. Therefore, invasive or non-invasive measurement of cardiac output is recommended.
5. Add IV dobutamine (2-5 mcg/kg/min) if ScvO<sub>2</sub> < 70% or if patient has low cardiac output
  - Caution: Ensure hypovolemia is corrected as dobutamine may decrease blood pressure

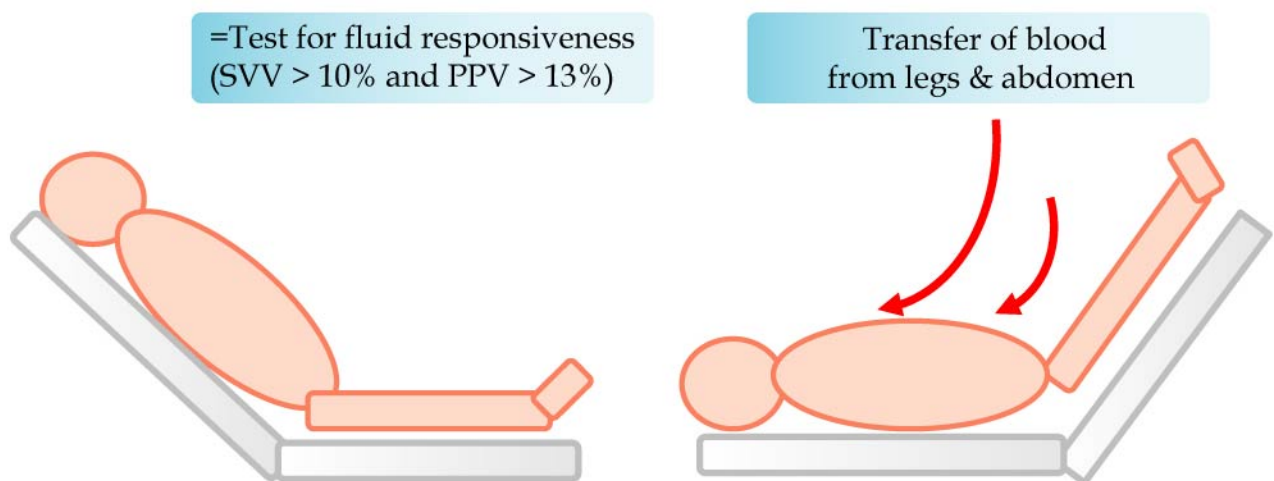
### *Inotropic and vasopressor support in cardiogenic shock*

Cardiogenic shock is a physiologic state in which inadequate tissue perfusion is a result from cardiac dysfunction. Decreased cardiac output (CO) and evidence of tissue hypoxia despite adequate intravascular volume are hallmark of the condition. Hemodynamic criteria for cardiogenic shock are sustained hypotension (systolic BP < 90 mmHg for at least 30 min) with reduced cardiac index (< 2.2 L/min/m<sup>2</sup>) and pulmonary capillary occlusion pressure (>15 mmHg).

1. Correct hypovolemia and hypotension with judicious fluid replacement, unless pulmonary edema is present. Ensure MAP ≥ 65 mmHg.
2. Early cardiology consult is recommended if cardiogenic shock is due to acute myocardial infarction in view of rescue revascularization. Use of intra-aortic balloon pump may be considered.
3. Inotropic agents are indicated to improve symptoms and end organ function in patient with low output state, left ventricular systolic dysfunction and systolic BP < 90 mmHg despite adequate preload.
  - a. Dobutamine
    - First line therapy for patient with normal or moderately reduced BP in the presence of pump failure and volume overload
    - Dose 2-20 mcg/kg/min
    - Start 2-3 mcg/kg/min and slowly increase until hemodynamic parameters improve
    - In patient receiving beta-blocker, increasing the dose to 20 mcg/kg/min may be necessary to restore its inotropic effect

## Inotropic and Vasopressor Support in Intensive Care

- b. Noradrenaline
  - Use to restore coronary perfusion
  - Recommended as first line therapy in the presence of severe hypotension
  - Usual dose range 0.2-1.5 mcg/kg/min
- c. Dopamine
  - Dose 3-20 mcg/kg/min
  - Caution: Dopamine causes cardiac arrhythmias and higher risk of death in cardiogenic shock
- d. Phosphodiesterase inhibitor e.g. milrinone
  - Dose 0.375–0.75 mg/kg/min
  - Caution: Concomitant administration of vasopressor may be required

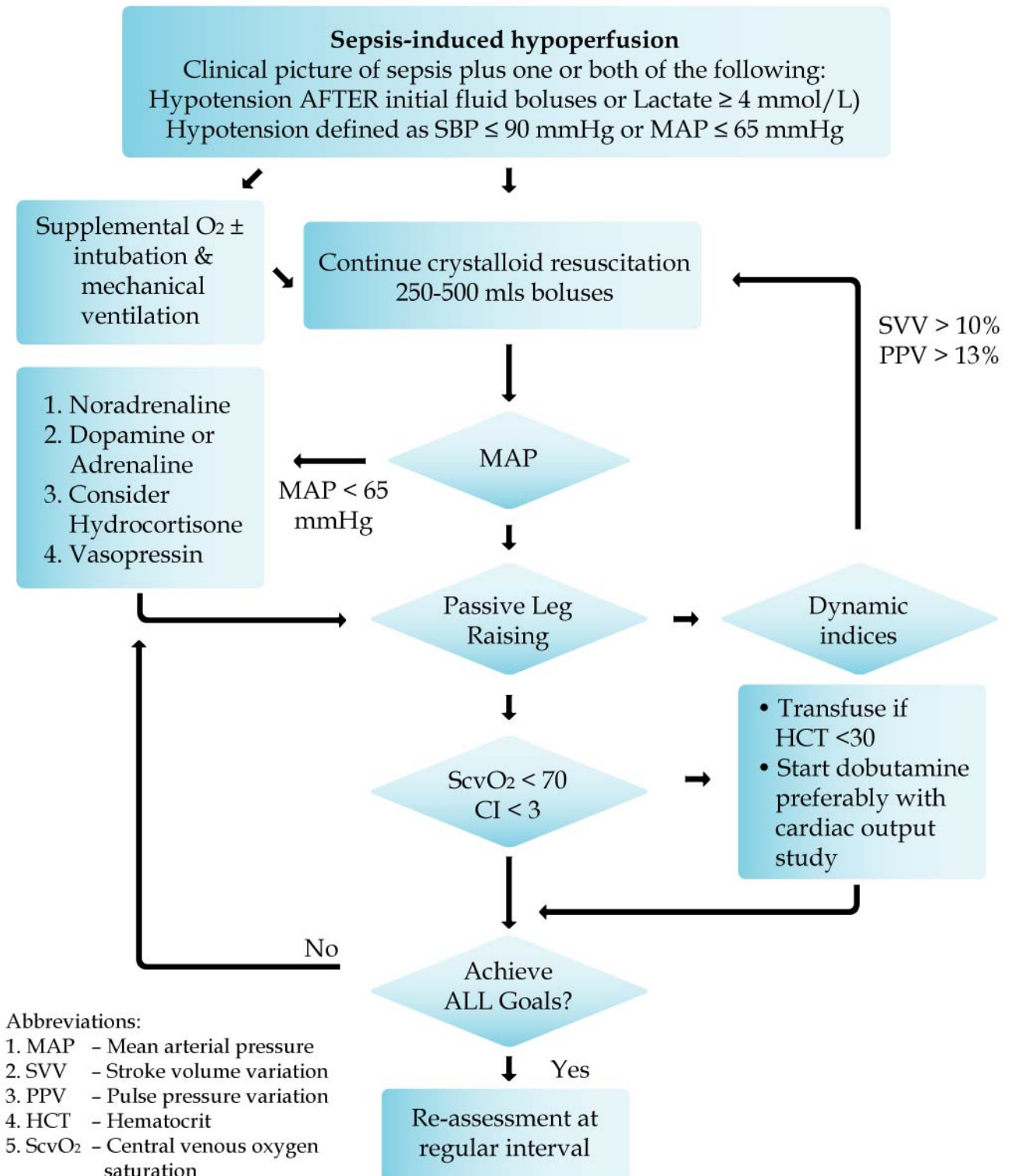


### Figure 1 Passive leg raising (PLR) test.

*The PLR test consists of measuring hemodynamic effects of leg elevation up to 45 degree. Simple way to perform the test is to transfer patient from semi-recumbent posture to PLR position by using automatic motion of the bed. Hemodynamic effects of PLR should be assessed within 30-90s after the onset of test.*

# Inotropic and Vasopressor Support in Intensive Care

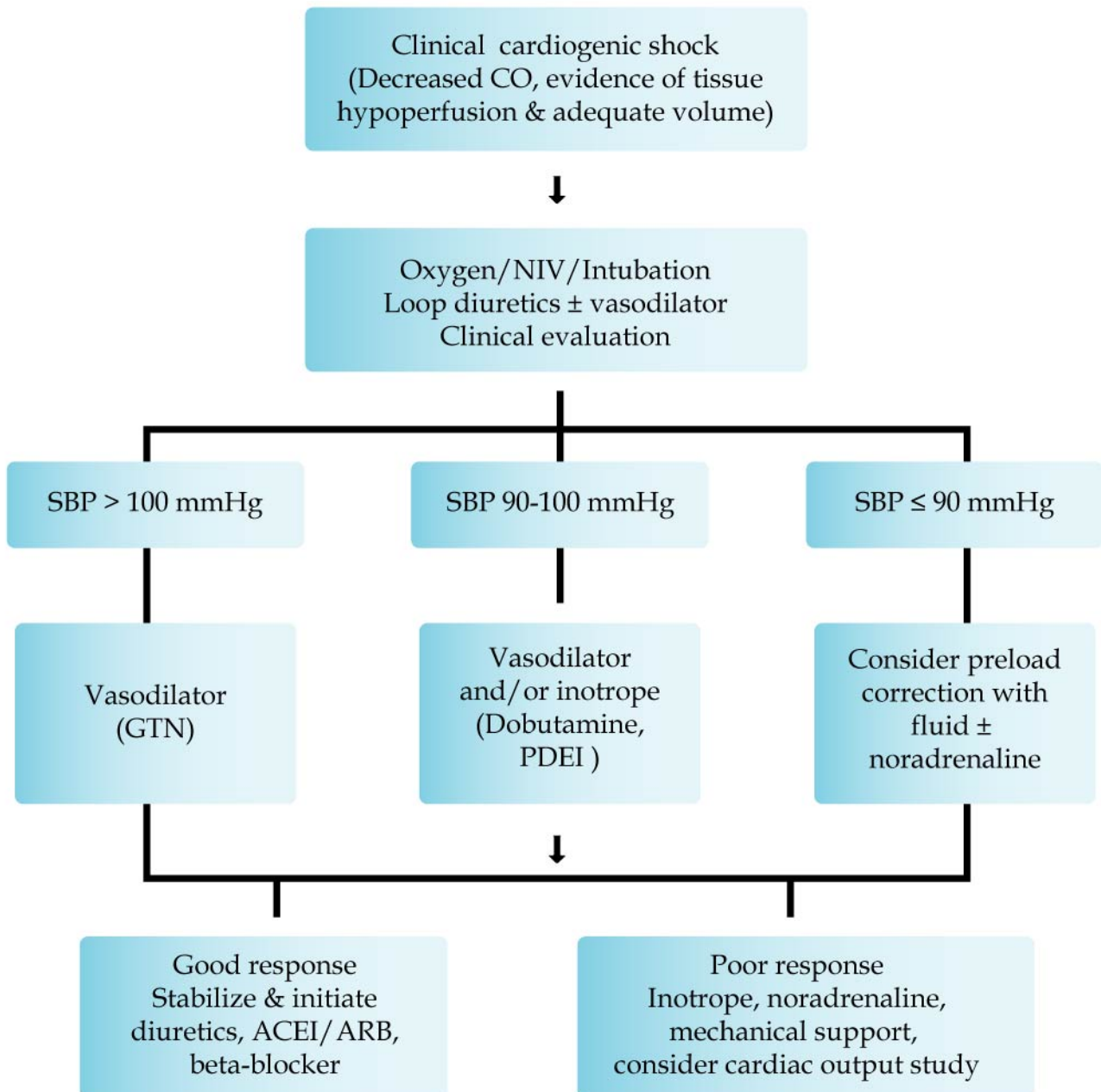
## Management of Septic Shock





# Inotropic and Vasopressor Support in Intensive Care

## Treatment Strategy of Cardiogenic Shock according to Systolic BP



### Abbreviations:

1. GTN – Glyceryltrinitrate
2. ACEI – Angiotensin-converting enzyme inhibitor
3. PDEI – Phosphodiesterase inhibitor
4. ARB – Angiotensin renin blocker



# Inotropic and Vasopressor Support in Intensive Care

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# Enteral and Parenteral Nutrition in the Intensive Care Unit

### Introduction

Nutritional therapy is an integral part of ICU care. The goals are to provide adequate calories and protein to keep up with ongoing losses, prevent or correct nutrient deficiencies and promote wound healing and immune function.

### Principles

1. Enteral feeding should be commenced as soon as possible.
2. Enteral nutrition (EN) is preferred over parenteral nutrition (PN) in the critically ill.
3. Parenteral nutrition (PN) is not without risks and to be started when clearly indicated.
4. Overfeeding should be avoided.
5. Patients at risk of refeeding syndrome should be identified before initiation of nutritional therapy.

### Enteral Nutrition (EN)

1. Commence enteral feeding within 24-48h of ICU admission if the gastrointestinal tract is functioning and the patients have been adequately resuscitated.
2. For patients who have undergone recent bowel anastomosis, prior discussion between the surgeon and ICU specialist may be required before commencement of enteral feeding.
3. Enteral feeding will be carried out using a nasogastric or orogastric tube. Use 12FG in adults. Confirm the correct position of the tube by any two of the following methods (i) aspirating for gastric contents (ii) injecting 10-20 ml of air down the tube and auscultating the epigastric area and (iii) radiography.
4. Confirm that the feeding tube is in the correct position before each feed by checking the external length of the tube and by auscultating the epigastric area.



# Enteral and Parenteral Nutrition in the Intensive Care Unit

## Enteral nutrition (EN)

5. Use any of the 3 methods to administer enteral feeding:

i. **Continuous feeding method 1** (Refer to algorithm 1)

Start at 20-40mls/h continuously. Aspirate the feeding tube q4h.

If aspirates < 300mls, return all aspirates. Increase rate by 20mls/h every 2 cycles till a flow rate that meets the caloric needs of the patient.

If aspirates > 300mls, return 300mls aspirate to patient and reduce rate by 50% of initial rate. Exclude bowel obstruction. If there is no clinical evidence of bowel obstruction, administer prokinetic agents. Once further aspirates are < 300mls, feeding may be increased by 20mls/h every 2 cycles. If aspirate continues to exceed 300 mls, consider small bowel feeding and elemental formulas.

ii. **Continuous feeding method 2**

Start at 25mls/h for 4h followed by 2h rest. Aspirate just prior to the next cycle. If aspirate <300mls, increase rate by 25mls/h per cycle. If aspirate >300mls, reduce rate by 50% of the initial rate.

iii. **Intermittent bolus feeding**

Start with 50mls q3h. Aspirate before every feed. If aspirates < 300mls, return aspirates to patient. Increase by 50mls after every 2 feeds till caloric needs are met.

If aspirates >300mls, return 300mls aspirate to patient and reduce by 50mls per feed. Exclude bowel obstruction. If there is no clinical evidence of bowel obstruction, administer prokinetic agents. Once further aspirate is < 300mls, feeding may be increased by 50mls after every 2 feeds. If aspirate continues to exceed 300 mls, consider continuous feeding.

6. Do not withhold feeding for procedures /diagnostic tests not involving the airway or gastrointestinal tract and for planned extubation unless there is a high risk of re-intubation or anticipated difficult airway.



## Enteral and Parenteral Nutrition in the Intensive Care Unit

7. Enteral formula safety:
  - i. Use sterile water for formula reconstitution, medication dilution and tube flushing.
  - ii. Duration of hang time:
    - a) For closed system, the duration of hang time is 24-48h per manufacturer recommendation. Closed system refers to the "ready to hang formulas".
    - b) For sterile decanted formula, the duration of hang time is 8h.
    - c) For powdered, reconstituted formula, the duration of hang time is 4h.
  - iii. Change administration sets for open system q24h.
  - iv. Opened unused sterile decanted formula must be refrigerated and discarded within 24h.
8. Enteral formula
  - i. Consider peptide based or elemental formulas (eg Peptamen) in patients with gastrointestinal complications (short bowel syndrome, pancreatitis).
  - ii. Consider low volume calorie-dense formulations (1.5-2.0 kcal/ml) in patients who require fluid restriction.
  - iii. Consider enteral glutamine at 0.3 to 0.5 gm/kg/day in two to three divided doses in burns and trauma patients.
9. Calorie and protein requirements
  - i. During the acute and initial phase of critical illness, provide non protein calories at 20-25 kcal/kg/day.  
During the recovery phase, provide non protein calories at 25-30 kcal/kg/day.  
Use ideal body weight.  
For underweight patients, use actual body weight.
  - ii. Protein should be supplied at least 1.2-1.5 g/kg/day.
10. Enteral feeding intolerance
  - i. Monitor patient's gastrointestinal tolerance to feeding q4h. Look for diarrhea, abdominal distension, high gastric residual aspirates and multiple emetic episodes. Do not stop enteral feeding unnecessarily.
  - ii. Consider small bowel feeding (nasojejunal/nasoduodenal) in patients with feeding intolerance or in pancreatitis.
  - iii. Use motility agents such as IV metochlopramide 10-20mg q6-8h and/or IV erythromycin 125 mg q6h or 250 mg q12h.
  - iv. Refer to algorithm 2 for the management of diarrhea.



# Enteral and Parenteral Nutrition in the Intensive Care Unit

## *Parenteral nutrition (PN)*

1. Indications for parenteral nutrition
  - i. In patients with no evidence of protein-calorie malnutrition, initiate PN only after the first 7 days of hospitalization when EN is not feasible
  - ii. If a patient is malnourished and is expected to undergo major upper GI surgery and EN is not feasible, initiate PN 5-7 days preoperatively and continue it into the postoperative period
  - iii. For postoperative patients, initiate PN only after 7 days of operation when EN continues not to be feasible
  - iv. If there is evidence of protein-calorie malnutrition [recent weight loss >10-15% or ABW<90% of IBW] on admission and EN is not feasible, initiate PN as soon as possible
  - v. For patients with post-operative complications impairing gastrointestinal function and who are unable to receive EN for at least 7 days, initiate PN early
  - vi. In high output enterocutaneous fistulae, initiate PN early if >60% of energy needs are not met with EN after 2 days
2. Administration of parenteral nutrition
  - i. Administer high osmolarity PN through a dedicated lumen of a multi-lumen central line
  - ii. Low osmolarity (<850mOsmol/L) PN may be administered via a dedicated peripheral venous line
3. Requirements:
  - i. During acute illness, the non-protein caloric requirements are 20-25 kcal/kg/day increasing to target over the next 2-3 days
  - ii. The minimal amount of carbohydrate required is about 2g/kg of glucose per day
  - iii. Lipids are provided at 0.7-1.5g/kg/day
  - iv. Glucose : fat calorie ratio are around 60:40 or 70:30 of the non protein calories in order to avoid hyperlipidemia and fatty liver
  - v. Proteins are provided at 1-1.5g/kg IBW/day
  - vi. Consider parenteral glutamine in the dose of 0.3-0.6g/kg/day
  - vii. Include a daily dose of multivitamins and trace elements
  - viii. Prescribe electrolytes according to serum levels
4. Monitoring:
  - i. Blood glucose levels q4-6h
  - ii. Daily renal profile
  - iii. Biweekly liver function tests, serum lipid profile, phosphate, magnesium and calcium levels
  - iv. Central venous catheter-related sepsis



# Enteral and Parenteral Nutrition in the Intensive Care Unit

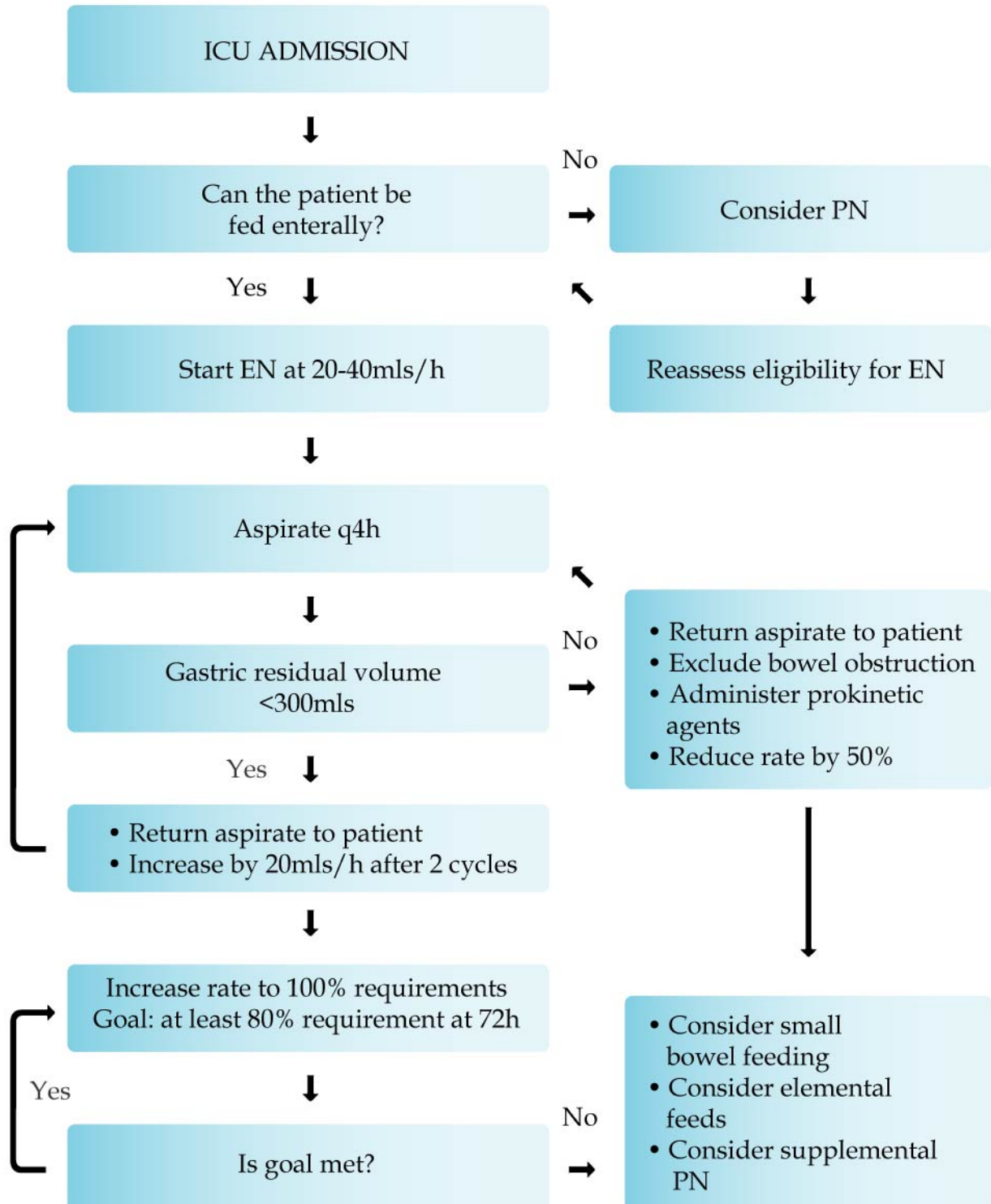
5. Weaning from PN :  
PN can be terminated once the provision of EN exceeds 60%.

## *Nutrition therapy in special conditions*

1. Acute kidney injury
  - Use standard enteral nutrition formulations
  - Consider low volume calorie-dense formulations if fluid restriction is required or formulations with lower content of electrolytes if electrolyte abnormalities exist or develop
  - Provide non-protein calorie at 20-30 kcal/kg/day
  - Provide a total protein intake of 2.0-2.5 g/kg/day in patients undergoing continuous renal replacement therapy and haemodialysis
2. Acute hepatic failure
  - Use standard enteral formulations and do not restrict protein intake
  - Provide energy requirements at 1.3 times the normal requirement and proteins at 0.8-1.2 g/kg/day
3. Burns
  - There are many mathematical equations devised to estimate caloric needs of the patient. However, there is no single formula that accurately assesses the true caloric needs and continued vigilance is required to avoid complications associated with either overfeeding or underfeeding.
  - Refer to Appendix 1 for one formula to estimate caloric needs for the burns patient
  - Glucose is provided at 5-7 mg/kg/min which represents approximately 50% of total caloric intake
  - Proteins are provided at 1.5-2 g/kg/day
  - Consider enteral glutamine at 0.3 to 0.5 gm/kg/day in two to three divided doses in burns patients
4. Obesity:
  - For obese patients (BMI > 30), allow permissive underfeeding or hypocaloric feeding
  - Energy goal should not exceed 60-70% of target non-protein calorie requirements (11-14 kcal/kg actual BW/day or 22-25 kcal/kg IBW/day)
  - Protein are provided at  $\geq 2.0$ g/kg IBW/day for BMI 30-40 and at  $\geq 2.5$  g/kg IBW/day for BMI  $\geq 40$
  - Providing 60-70% of caloric requirements promotes steady weight loss, while infusing protein at 2-2.5g/kg IBW/day should approximate protein requirements and neutral nitrogen balance

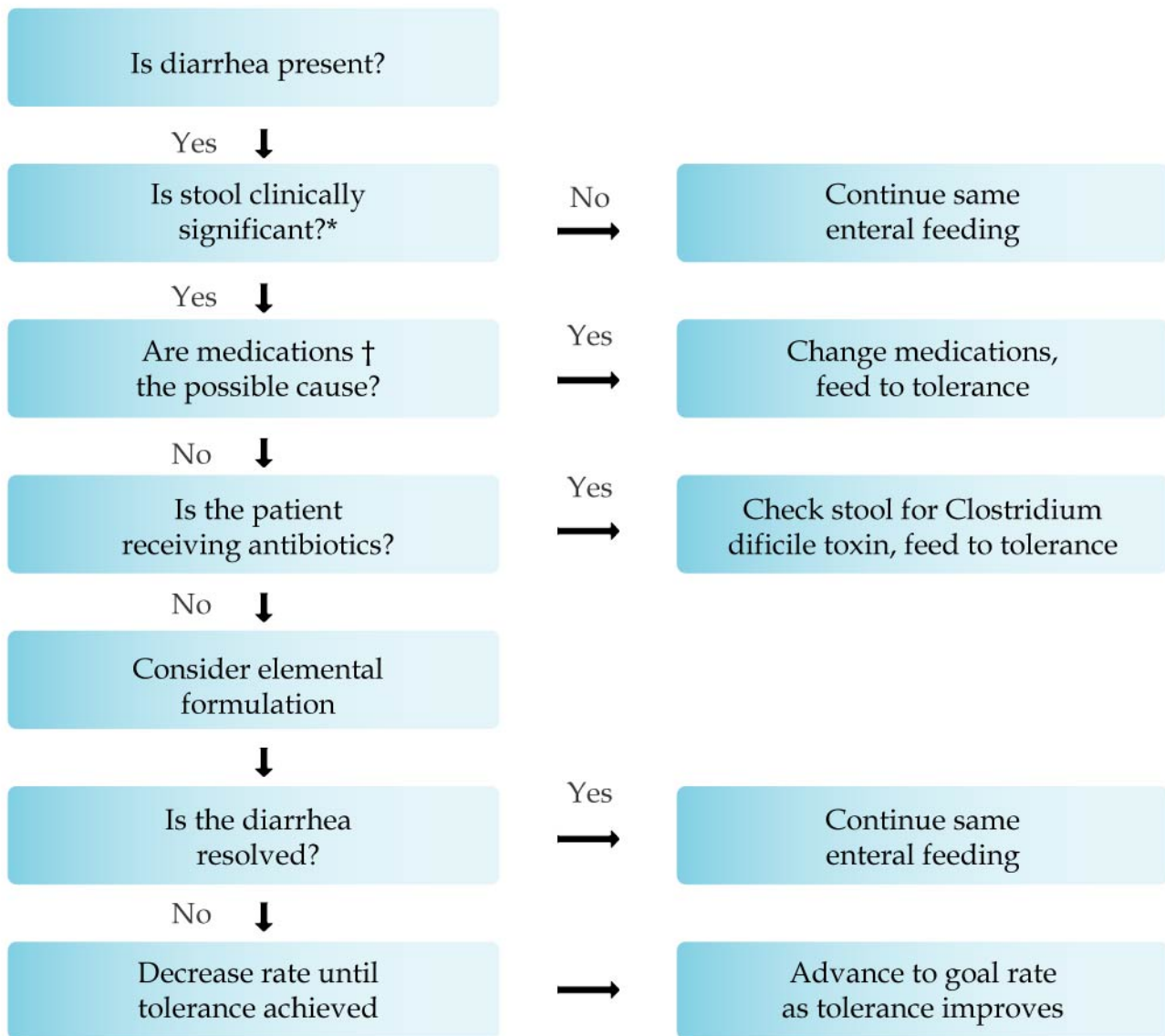
# Enteral and Parenteral Nutrition in the Intensive Care Unit

## Algorithm 1: Continuous Enteral Feeding



# Enteral and Parenteral Nutrition in the Intensive Care Unit

## Algorithm 2: Management of Diarrhea



\* Clinically significant stool:

- Liquid stools volume >300mls/d or >4 episodes/d or risk of contamination to wounds/catheters

† Medications

- Antibiotics
- Metochlopramide
- Aminophylline
- Magnesium
- Erythromycin
- Medications containing sorbitol



# Enteral and Parenteral Nutrition in the Intensive Care Unit

## Appendix 1 Harris-Benedict equation

1. Widely used algebraic formula for the estimation of caloric requirements in adult burn patients especially for the initial nutritional management
2. It estimates the basal energy expenditure (BEE)
3. As this equation can overestimate caloric requirements of burns patient, continued vigilance and monitoring is required to avoid overfeeding
4. For all but the most extensive burn injuries, the BEE is multiplied by an arbitrary activity or stress factor of between 1.2 and 1.5
5. For men:  
$$\text{BEE(kcal/d)} = 66.5 + (13.8)\text{weight in kg} + (5)\text{height in cm} - (6.76)\text{age in years}$$
6. For women:  
$$\text{BEE(kcal/d)} = 65.5 + (9.6)\text{weight in kg} + (1.85)\text{height in cm} - (4.68)\text{age in years}$$
7. Total caloric needs = BEE X 1.2 - 1.5



## Enteral and Parenteral Nutrition in the Intensive Care Unit

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# Sedation and Delirium in the Intensive Care Unit

### Introduction

The provisions of adequate analgesia and anxiolysis and the management of delirium are essential components of care in the critically ill.

An acutely changing or fluctuating mental status, inattention, disorganized thinking and an altered level of conscious state with or without agitation characterize delirium. It has 3 forms:

- a. Hypoactive : withdrawn
- b. Hyperactive : agitated and paranoid
- c. Mixed : combination of both

Both oversedation and delirium are associated with adverse outcomes. It is thus important to maintain a balance between the awake, oversedated and distressed patient. A sedation and delirium management protocol helps to achieve this balance.

### Principles

1. A sedation goal should be established and regularly redefined for each patient.
2. Use of a validated sedation assessment scale is recommended.
3. Analgesic and sedative requirements differ between patients. Dose requirements need to be titrated to individual patient needs and clinical effect.
4. Routine assessment for the presence of delirium is recommended.

### Sedation protocol

1. Not all patients admitted to ICU require continuous sedative infusion. Some patients require analgesia only.
2. Patients are to be assessed for sedation and agitation based on the revised Riker's Sedation-Agitation Scale (SAS) or Richmond Agitation and Sedation Scale (RASS) q4h.
3. Titrate the sedative infusion rate with the aim of keeping the SAS between -1 to +1 or RASS between -2 to +1.



## Sedation and Delirium in the Intensive Care Unit

4. The following patients should be sedated to achieve a SAS of -2 or -3 or RASS of -3 to -5:
  - a. head injury on cerebral protection
  - b. septic shock on high inotropic support (iv noradrenaline  $>0.15$  mcg/kg/min or dopamine  $>15$  mcg/kg/min or adrenaline  $>0.15$  mcg/kg/min)
  - c. ARDS on high ventilatory support ( $FiO_2 > 0.6$  and PEEP  $> 12$ )
  - d. tetanus
5. If the SAS is +2 or +3 or RASS is +2 to +4, follow the delirium management protocol.
6. If the SAS is -2 or -3 or RASS is -3 to -5, off sedative infusion. Assess 4h later. If clinically indicated, restart at half the infusion rate when the SAS is -1 or RASS of -2.
7. The standard sedative infusion to be used in patients admitted to ICU is midazolam and morphine. Midazolam 30 mg and morphine 30 mg is diluted with normal saline to 30 mls. The initial infusion rate is between 1 – 3 mls/h then titrated to clinical effect.
8. Fentanyl may be used in patients with encephalopathy, renal or hepatic impairment. Fentanyl 200 mcg is diluted with normal saline to 20 mls. The infusion rate is between 2-3 mls/h then titrated to clinical effect.
9. Postoperative patients admitted for short-term ventilation may need analgesia only. They may be started on infusion of:
  - a. morphine  $\pm$  propofol
  - b. morphine  $\pm$  dexmedetomidine
10. Withhold sedatives every morning at 8 am **except** in patients who require continuous deep sedation. Analgesic should be continued for patients requiring pain relief
11. Patients who are paralysed need not be scored. Denote “P” for them.
12. Weaning off sedative infusions: The potential for benzodiazepine withdrawals should be considered in patients receiving high dose or more than 7 days of infusion. Doses should be tapered off systematically by 10% - 30% per day to prevent withdrawal symptoms.

# Sedation and Delirium in the Intensive Care Unit

## Revised Riker Sedation-Agitation Scale

Scale	Description	Definition
<b>+3</b>	<b>Agitated and restless</b>	When awoken or otherwise, pulling at ETT, trying to remove catheters or requires physical restraints
<b>+2</b>	<b>Awake but mildly agitated</b>	Anxious but mildly agitated. Attempts to sit up but calms down with verbal instructions
<b>+1</b>	<b>Aroused by voice and remains calm</b>	Awakens easily to verbal stimuli. Remains awake, calm and easily follows command
<b>0</b>	<b>Awake and calm</b>	Awake, calm and easily follows commands
<b>-1</b>	<b>Aroused by movement</b>	Awakens to loud verbal stimuli or gentle shaking. Has eye contact for at least 10 seconds but drifts off to sleep OR Awakens to loud verbal stimuli or gentle shaking and follows simple commands
<b>-2</b>	<b>Aroused by painful stimuli</b>	Localising or flexion to pain. Does not communicate or follow commands
<b>-3</b>	<b>Unarousable</b>	Extension, minimal or no response to painful stimuli

### ASSESSMENT

1. Observe patient: Is the patient awake and calm? If yes, score 0
2. If the patient is not awake, call the patient's name out or lightly tap on the shoulder. If awakens and remains awake, score is +1 but if drifts off to sleep after eye contact, score is -1
3. Is the patient restless or agitated? If yes, score +2 or +3 based on the criteria above
4. If does not respond to voice or gentle tapping, physically stimulate the patient. Observe response and score -2 or -3 based on the criteria above

# Sedation and Delirium in the Intensive Care Unit

## Richmond Agitation and Sedation Scale

Scale	Description	Definition
<b>+4</b>	<b>Combative</b>	Overtly combative or violent; immediate danger to staff
<b>+3</b>	<b>Very agitated</b>	Pulls on or removes tube(s) or catheter(s) or has aggressive behaviour toward staff
<b>+2</b>	<b>Agitated</b>	Frequent non purposeful movement or patient-ventilator dyssynchrony
<b>+1</b>	<b>Restless</b>	Anxious or apprehensive but movements not aggressive or vigorous
<b>0</b>	<b>Alert and calm</b>	
<b>-1</b>	<b>Drowsy</b>	Not fully alert, but has sustained (more than 10 seconds) awakening, with eye contact to voice ie Eye contact > 10 seconds with verbal stimulation
<b>-2</b>	<b>Light sedation</b>	Briefly (less than 10 seconds) awakening with eye contact to voice ie Eye contact < 10 seconds with verbal stimulation
<b>-3</b>	<b>Moderate sedation</b>	Any movement but no eye contact to verbal stimulation
<b>-4</b>	<b>Deep sedation</b>	No response to voice, but any movement to physical stimulation
<b>-5</b>	<b>Unarousable</b>	No response to voice or physical stimulation

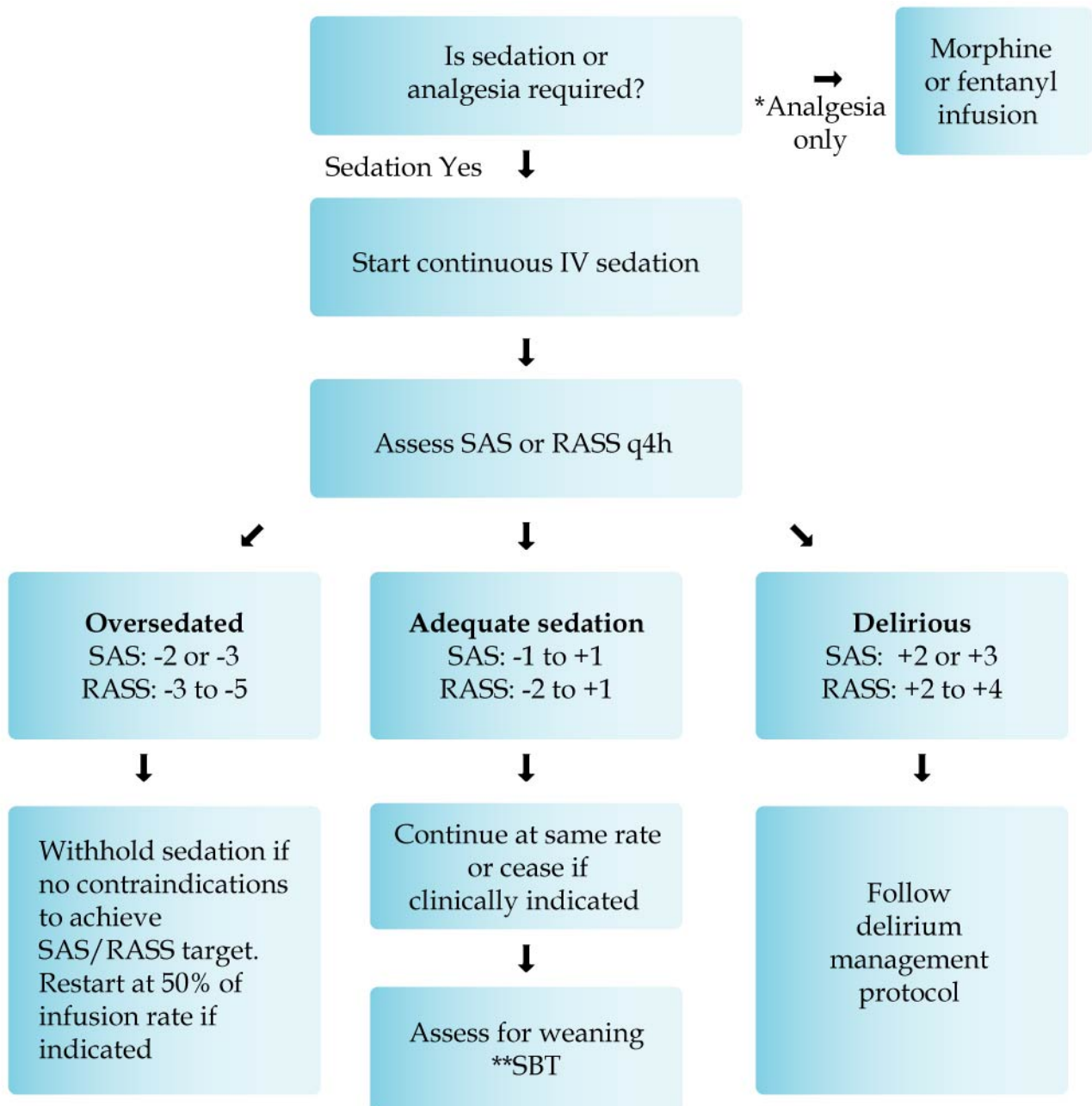
### ASSESSMENT

1. Observe the patient. If patient is alert and calm, score 0
2. Is the patient restless and agitated? Score +1 to +4 using the criteria listed under description
3. If the patient is not alert, call the patient's name loudly and direct the patient to open his eyes and look at you  
Patient has eye opening and contact which is sustained for 10 seconds, score -1  
Patient has eye opening and contact which is not sustained for 10 seconds, score -2  
Patient has movement to voice but no eye contact, score -3
4. If the patient has no response to voice, physically stimulate the patient by shaking his shoulder or rubbing his sternum. Observe response and score -4 or -5 based on the above criteria



# Sedation and Delirium in the Intensive Care Unit

## Sedation Protocol in Mechanically Ventilated Patients



**Note:**

Sedation should be withheld every morning at 8am except when contraindicated.

\* Analgesia is required in postoperative cases and acute coronary syndrome.

\*\* SBT: Spontaneous breathing trials



# Sedation and Delirium in the Intensive Care Unit

## *Delirium Management Protocol*

1. All patients with a SAS > - 2 or RASS of > - 3 should be screened by the nursing staff for delirium using the Confusion Assessment Method for ICU (CAM - ICU) q8h.
2. The overall CAM-ICU must be documented in the nursing chart. However if possible, individual feature documentation may be better as it helps with accuracy and compliance of the overall assessment.

Overall CAM-ICU score
Present
Absent
UTA( Unable to assess)

3. Prevention is the main strategy in the management of delirium.
  - a. Provide adequate analgesia and anxiolysis while avoiding oversedation
  - b. Withhold sedation every morning at 8 am except when contraindicated
  - c. Correct physiological disturbances:
    - i. hypoxia, hypercarbia, acidosis
    - ii. drug withdrawal (heroin, opioids, alcohol)
  - d. Avoid rapid discontinuation of sedatives after prolonged (usually > 7 days) and high dose as this could lead to withdrawal symptoms. Wean off sedatives by 10% - 30% per day
  - e. Consider using a central  $\alpha$ -2 agonist for sedation ie dexmedetomidine in patients who are ready to be weaned or who have failed weaning
  - f. Provide psychological support and orientation
    - i. Consistently reorientate patient to time and place
    - ii. Involve family members to reorientate patient
    - iii. Allow patient to watch television or read the papers during the day
  - g. Allow an environment to sleep at night
    - i. Minimise noise and light at night
    - ii. Minimise nocturnal interventions if clinically possible
    - iii. Use night sedation as a last resort

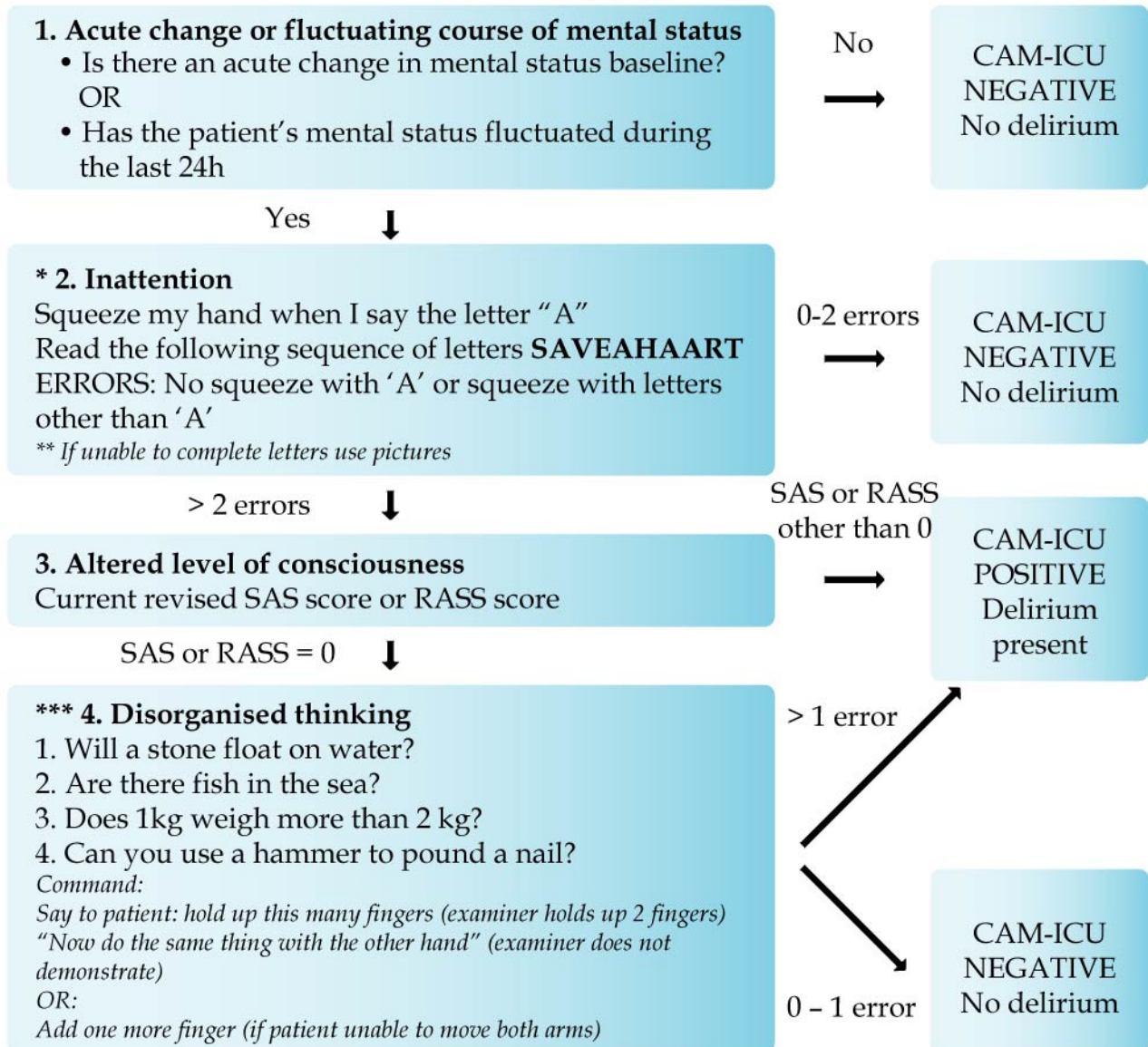


## Sedation and Delirium in the Intensive Care Unit

4. Treatment of delirium
  - a. Identify and treat predisposing factors to delirium such as pain, metabolic and hemodynamic instability, drug or alcoholic withdrawal etc
  - b. The following drugs may be used to treat delirium
    - i. IV Haloperidol: <60 yrs: 5 -10 mg PRN/q4-6h  
>60 yrs: 2.5 -5 mg PRN/q4 -6h
    - ii. T. Chlorpromazine: 12.5 – 25 mg q6-8h
    - iii. T. Risperidone: 0.5 – 1 mg q12h
    - iv. IVDexmedetomidine: 0.2 – 1.5mcg/kg/h  
(consider in patients who are ready to be weaned but agitated)
    - v. T. Olanzapine: 5 – 10 mg q12- 24h
    - vi. T. Quetiapine: 50 – 100 mg q12h  
Caution: Prolonged QT may occur with the use of all the above drugs except Dexmedetomidine
5. Access the following website for further use and training of the CAM-ICU:  
<http://www.icudelirium.org>

# Sedation and Delirium in the Intensive Care Unit

## Confusion Assessment Method for ICU (CAM- ICU)



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\* Patients with ICU-acquired weakness or neuromuscular disease may need an alternative method to indicate response eg eye blinks or finger taps

\*\* The pictures can be downloaded from the following website: <http://www.icudelirium.org>

\*\*\* Assessment of feature 4 requires both questions and commands to be completed. If patient is paralysed or blind, only questions need to be answered and this feature is present if there are > 1 error

# Sedation and Delirium in the Intensive Care Unit

## CAM- ICU WORKSHEET

	Score	Present
<b>Feature 1: Acute onset or fluctuating course</b>		
Is the patient different from his /her baseline mental status OR Has the patient's mental status fluctuated in the last 24h based on the Sedation Scale	If yes to either questions?	<input type="checkbox"/>
<b>Feature 2: Inattention</b>		
Tell the patient to squeeze your hand whenever you say the letter "A". Read the letters in a normal tone 3 seconds apart "SAVEAHAART" Errors are counted when the patient does not squeeze your hand with the letter 'A' or squeezes your hand with letters other than A If unable to complete letters use pictures	Number of errors >2	<input type="checkbox"/>
<b>Feature 3. Altered level of consciousness</b>		
Current sedation score other than 0	Yes	<input type="checkbox"/>
<b>Feature 4: Disorganized thinking</b>		
Yes/No questions 1. Will a stone float on water? 2. Are there fish in the sea? 3. Does 1kg weigh more than 2 kg? 4. Can you use a hammer to pound a nail? Command: How many fingers (hold up 2 fingers) Now do the same thing to the other hand OR: "Add one more finger"(if patient unable to move both arms) Both question and command to be completed	Combined errors > 1	<input type="checkbox"/>

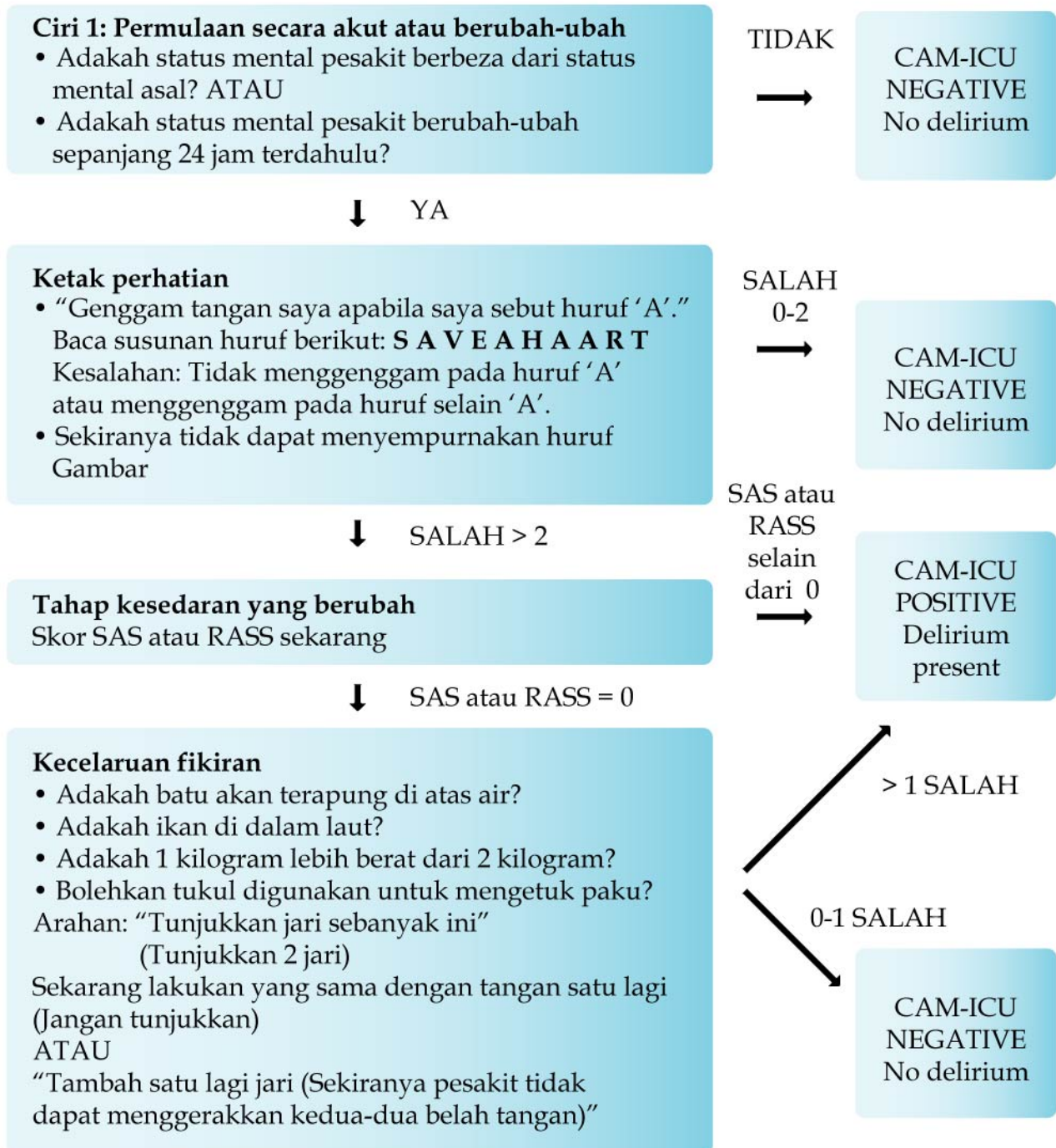


### Overall CAM-ICU

**Features: 1 + 2 AND either 3 or 4 present > CAM -ICU POSITIVE**

# Sedation and Delirium in the Intensive Care Unit

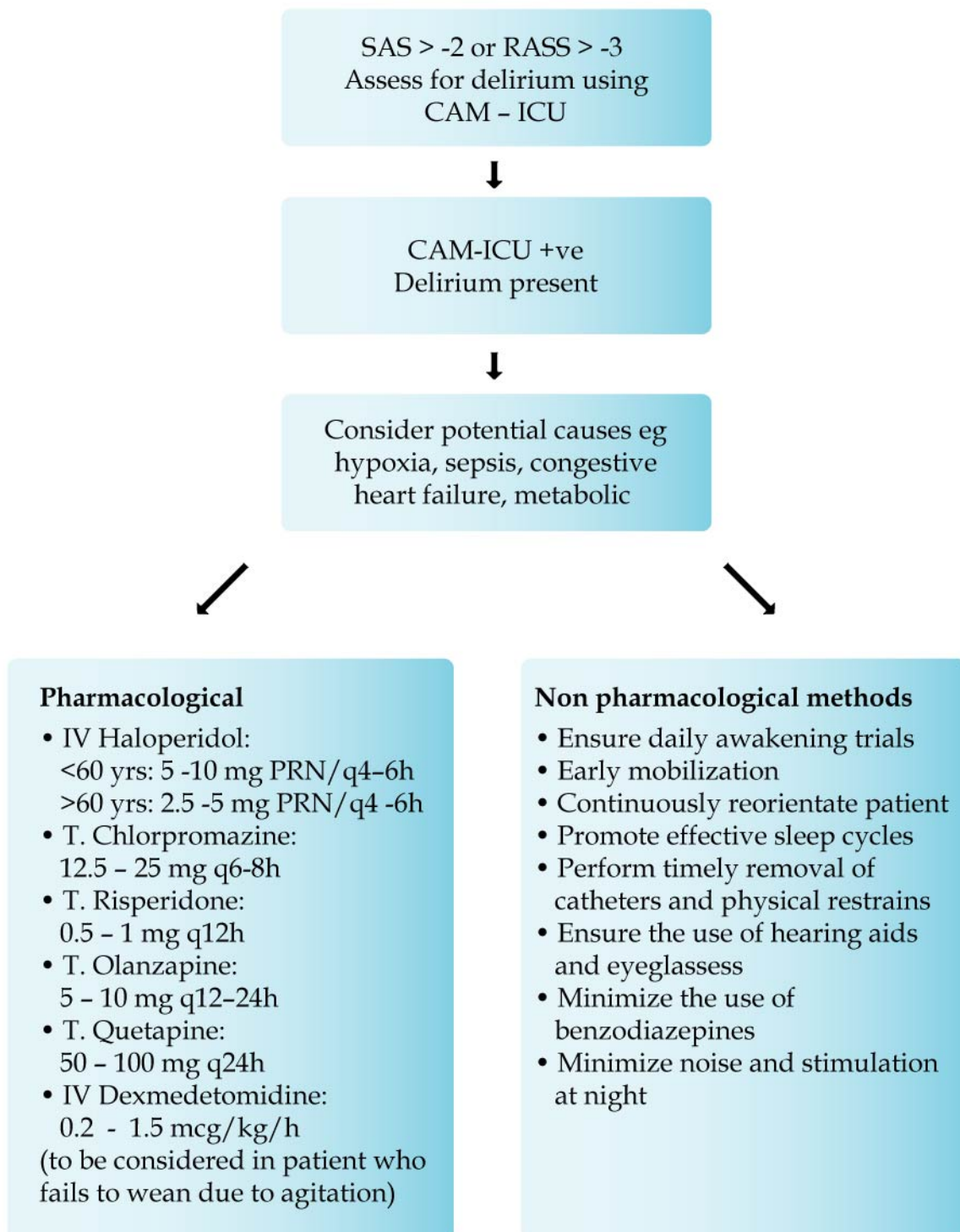
## Carta Confusion Assessment Method for ICU (CAM-ICU)





# Sedation and Delirium in the Intensive Care Unit

## Delirium Assessment & Management Algorithm





## Sedation and Delirium in the Intensive Care Unit

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# Venous Thromboembolism Prophylaxis

### Introduction

Venous thromboembolism (VTE) is an important cause of mortality and morbidity in intensive care units. The rationale for VTE prophylaxis is based on its efficacy, the clinically silent nature of VTE, its high prevalence in critically ill patients and its potentially disabling or fatal consequences.

### Principles

1. Pharmacological prophylaxis is the most effective method of VTE prophylaxis but carries the risk of bleeding.
2. Low molecular weight heparin (LMWH) have a number of potential advantages over low dose unfractionated heparin (LDUH) which include once daily administration, greater bioavailability, lower incidence of heparin-induced thrombocytopenia and cost effectiveness due to less laboratory monitoring.
3. Mechanical methods of prophylaxis should be used routinely in whom pharmacological prophylaxis is contraindicated.
4. Graded compression stockings or elastic stockings are considered the least effective method of VTE prophylaxis and should never be used alone in patients with a moderate or high risk of VTE.
5. Intermittent pneumatic compression pumps are considered more effective than graded compression stockings and can be used alone as a replacement for pharmacologic prophylaxis in patients who are bleeding or have a high risk of bleeding.
6. Combined pharmacological and mechanical prophylaxis may provide greater protection than either alone.
7. Early ambulation remains the most important non pharmacological approach to the prevention of VTE.
8. There is no place for routine screening of patients for asymptomatic deep vein thrombosis as this strategy is neither effective nor cost-effective.



# Venous Thromboembolism Prophylaxis

## *Assessment of clinical risk factors for VTE in critically ill patients:*

- Recent surgery
- Trauma, burns
- Malignancy/Cancer and its treatment
- Sepsis
- Immobilization/bed rest/pharmacological paralysis/sedation
- Stroke, spinal cord injury
- Age > 40 years
- Cardiac/respiratory failure
- Previous VTE
- Obesity
- Pregnancy/puerperium
- Oestrogen therapy
- Mechanical ventilation

## *Assessment of risk factors for bleeding:*

1. Active bleeding (such as upper gastrointestinal bleeding, liver laceration etc)
2. Acquired bleeding disorders (such as acute liver failure)
3. Concurrent use of anticoagulants known to increase the risk of bleeding (such as warfarin with INR > 2)
4. Acute stroke, active intracranial lesions
5. Thrombocytopenia (platelets <50,000/microliter of blood)
6. Uncontrolled systolic hypertension ( ≥ 230/120 mmHg )
7. Untreated inherited bleeding disorders (such as Haemophilia)

## *Protocol on VTE prophylaxis*

1. Assess all patients on ICU admission for risk of VTE and risk of bleeding and subsequently daily or more frequently if their clinical condition is changing rapidly.
2. Provide VTE prophylaxis to all patients admitted to the ICU according to the reason of admission, taking into account:
  - any planned interventions
  - the use of other therapies that may increase the risk of bleeding
3. Do not provide pharmacological prophylaxis to patients with any of the risk factors for bleeding, unless the risk of VTE outweighs the risk of bleeding.



## Venous Thromboembolism Prophylaxis

4. For neurosurgical patients, mechanical methods of prophylaxis are favored. However the use of heparin products is considered safe after 48 to 72h. Pharmacological prophylaxis should be avoided in patients with ruptured cranial or spinal vascular malformations (such as brain aneurysms) or acute traumatic or non-traumatic hemorrhage until the lesions have been secured or the condition is stable.
5. It is recommended to withhold pharmacological prophylaxis for 2 weeks after a thrombotic stroke and 1 week after an embolic stroke.
6. Withhold pharmacological prophylaxis with significant decrease in platelet count (30 to 50% of initial count), thrombocytopenia ( $< 50,000/\text{mm}^3$ ) or INR/APTT ratio  $> 1.5$ .
7. Do not withhold pharmacological prophylaxis for procedures or surgery unless there is a particularly high bleeding risk.
8. The insertion and removal of epidural catheters should coincide with the nadir of the anticoagulant effect (Refer Table 9.2)
9. Review the need for prophylaxis daily. Continue upon ICU discharge if still indicated.

### *Pharmacological prophylaxis:*

1. Low dose unfractionated heparin (LDUH)
  - Recommended dose: 5,000 units SC q8-12h depending on VTE risk factors
  - Refer Table 9.1 for dose adjustment
  - Stop LDUH 4 to 6h prior to elective surgery
  - Refer Table 9.2 for the use of LDUH in neuroaxial blockade
2. Low molecular weight heparin (LMWH)
  - Recommended dose: SC Enoxaparin 1mg/kg SC daily
  - Refer Table 9.1 for dose adjustment
  - Creatinine clearance  $< 30\text{ml/min}$ : SC Enoxaparin 0.5mg/kg daily
  - Body mass index (BMI)  $\geq 35$ : SC Enoxaparin 1mg/kg (ideal body weight) + 25% (actual body weight – ideal body weight)
  - Stop LMWH 24 h prior to elective surgery
  - Refer Table 9.2 for the use of LMWH in neuroaxial blockade

## Venous Thromboembolism Prophylaxis

### 3. Fondaparinux sodium

- Recommended dose: 2.5 mg SCq24h
- Refer Table 9.1 for dose adjustment  
BMI  $\geq 40$ : No dosing recommendation available  
Contraindicated in: BMI  $< 18.5$  or body weight  $< 50$  kg  
CrCl  $< 30$  ml/min  
Bacterial endocarditis
- Stop fondaparinux 2 to 4 days prior to elective surgery in patient with normal renal function. A longer period would be required in those with reduced renal function
- The approved dose for prevention of postoperative VTE is 2.5 mg SC q24h, to be initiated 8-12h following completion of surgery
- Refer Table 9.2 for the use of Fondaparinux in neuroaxial blockade

**Table 9.1: Dose Adjustment of Antithrombotics:**

	LDUH	Enoxaparin	Fondaparinux
<b>BMI <math>\geq 40</math></b>	5,000 units SC q8h	1mg/kg IBW + 25% (actual BW-IBW) SC q24h	No dosing recommendation available
<b>BMI <math>&lt; 18.5</math> or BW <math>&lt; 50</math>kg</b>	5,000 units SC q12h	30mg SC q24h	Contraindicated
<b>Renal impairment (CrCl <math>&lt; 30</math>)</b>	5,000 units SC q8-12h depending on VTE risk factors	0.5mg/kg SC q24h	Contraindicated

# Venous Thromboembolism Prophylaxis

*Table 9.2: Timing of neuraxial blockade in patients receiving VTE prophylaxis*

	LDUH	Enoxaparin		Fondaparinux
		Single-Daily Dosing:	Twice-Daily Dosing:	
<b>Insertion of catheter</b>	4h after the last dose	12h after the last dose	No recommendation (Delay block for 24h)	No recommendation
<b>Removal of catheter</b>	4h after the last dose	12h after the last dose	NA	36h after the last dose
<b>Subsequent dose after removal</b>	1h	4h	4h	12h
<b>Traumatic puncture</b>	Consider initiating prophylaxis after 6h	Consider initiating prophylaxis after 24h	NA	Single shot spinal safe but avoid epidural analgesia. Administration following nontraumatic puncture: 8-12h after

## *Mechanical VTE prophylaxis*

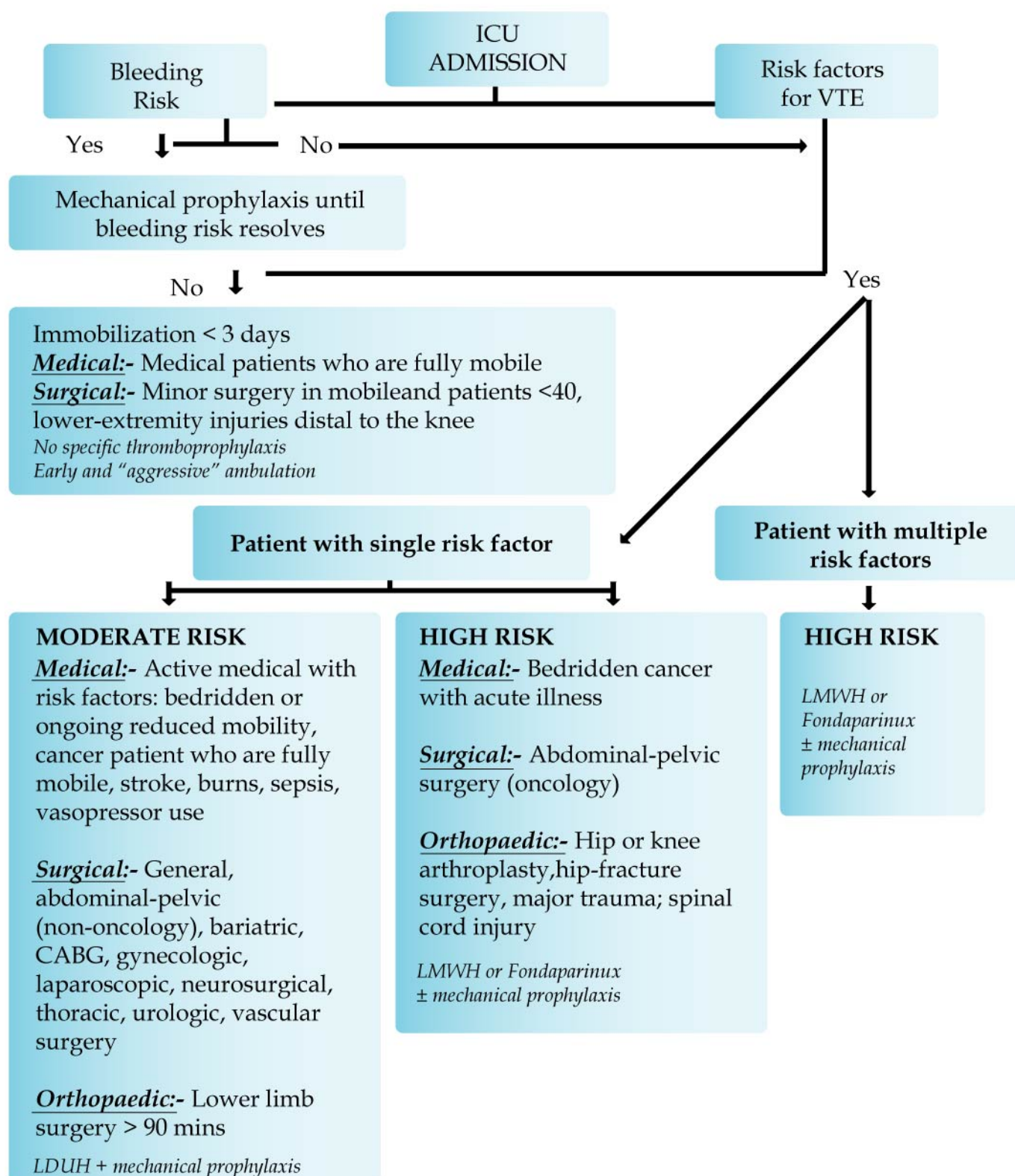
- Mechanical prophylaxis may enhance the effectiveness of pharmacological prophylaxis.
- Consider mechanical prophylaxis when pharmacological prophylaxis is contraindicated or as an adjunct to pharmacological prophylaxis.
- Monitor skin integrity regularly.

## *The following are contraindications to the use of Graded Compression Stockings:*

1. Arterial insufficiency (such as peripheral arterial disease)
2. Absent peripheral pulses
3. Suspected or proven deep vein thrombosis
4. Lower extremity ischemia or gangrene
5. Vein ligation / saphenous vein harvest / skin graft within 6 months
6. Dermatitis / loss of skin integrity

# Venous Thromboembolism Prophylaxis

## Algorithm for VTE Prophylaxis in ICU





# Venous Thromboembolism Prophylaxis

## *References:*

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# Stress Related Mucosal Disease (SRMD) Prophylaxis in The Intensive Care Unit

### Introduction

Stress related mucosal disease (SRMD) is erosion of the gastric mucosa that occurs in the critically ill. These erosions are often clinically silent but may cause significant gastrointestinal (GI) bleeding. The principal cause of SRMD is impaired blood flow and gastric acidity aggravates the disease.

### Principles

1. The goal of prophylaxis is to prevent bleeding from these gastric erosions.
2. Routine prophylaxis for all patients is not recommended as the risk differs between patients.
3. There is increasing evidence that enteral nutrition has protective effect on the gastric mucosa and enteral feeding may be adequate prophylaxis for SRMD in patients without risk factors.

### SRMD prophylaxis protocol

1. Start prophylaxis on patients with any one of the acute risk factors below:
  - mechanical ventilation (> 48h)
  - coagulopathy
  - hypoperfusion states and organ dysfunction (septic, haemorrhagic, cardiogenic, anaphylactic shock states)
  - severe head injury and/or spinal cord injury
  - severe burns (> 35%)
  - high dose corticosteroids (> 250mg hydrocortisone/day or its equivalent)
2. Consider prophylaxis for patients who are not fed and have two of the potential risk factors below:
  - concomitant use of a non-steroidal anti-inflammatory (NSAID) drug
  - concomitant use of corticosteroids
  - history of peptic ulcer disease (PUD), upper GI bleed or gastritis
  - mild to moderate brain/spinal cord injury



## Stress Related Mucosal Disease (SRMD) Prophylaxis in The Intensive Care Unit

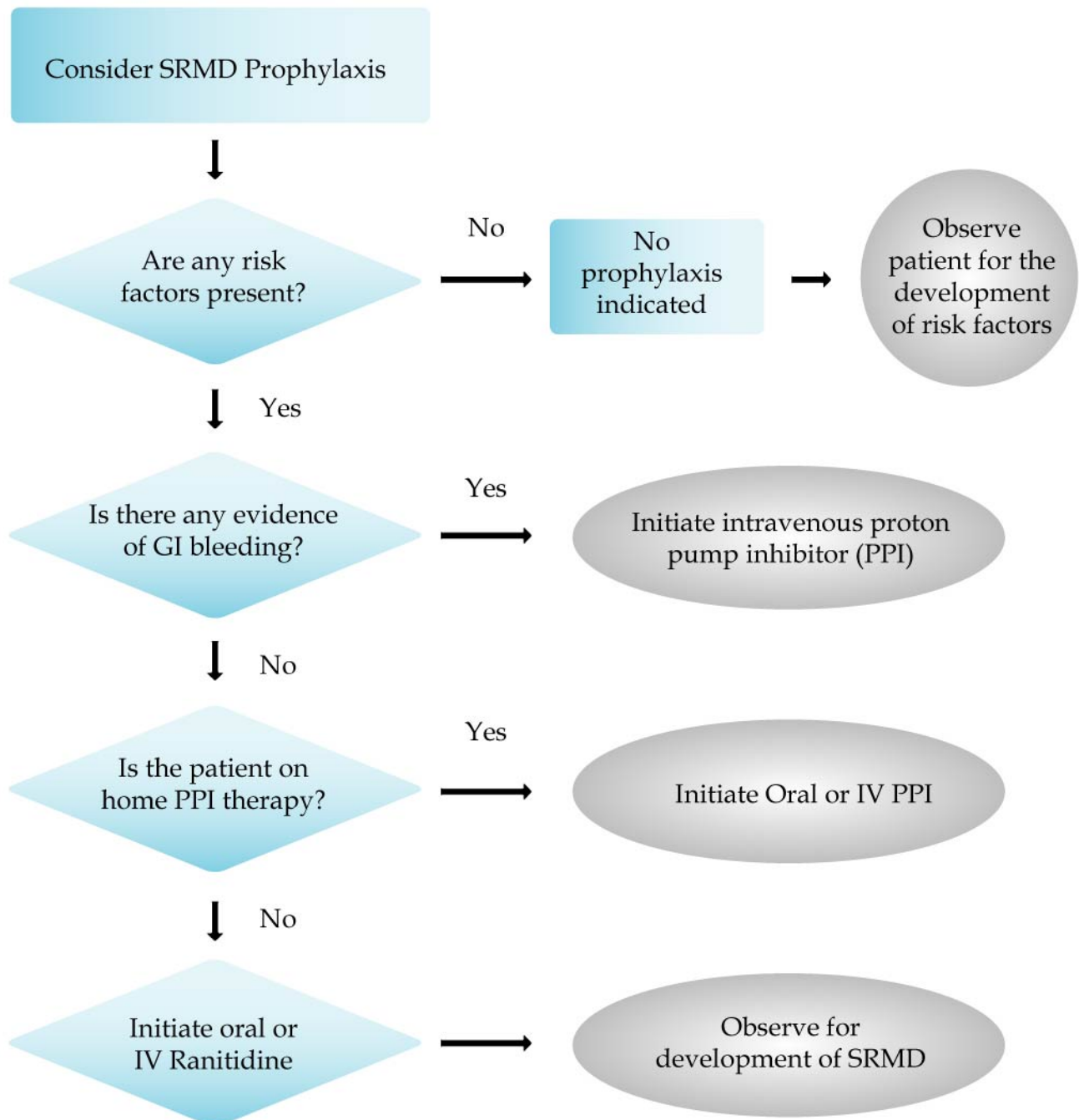
3. Prophylactic therapy for SRMD  
Use IV Ranitidine 50 mg q8h. Change to oral Ranitidine 150 mg q12h in patients who are enterally fed.
  - i. In renal failure, reduce IV dose to 50 mg q12h or oral 150 mg q 24h
  - ii. Proton pump inhibitors (PPI) is indicated in patients with proven ulcers and are already on PPI treatment. PPIs are not eliminated via the renal route and dose adjustment in renal impairment is not necessary
4. Treating active upper GI bleed in ICU
  - i. PPIs remain the main stay of treatment in patients that develop active upper GI bleeding
  - ii. Give PPI as an infusion 8 mg/h over 48 - 72h, following a loading dose of 80 mg, as adjunct to endoscopic or surgical management
  - iii. For those who develop clinically significant bleed in ICU, continue PPIs for at least 2 weeks (IV/oral Omeprazole or Pantoprazole or Esomeprazole 40 mg q12h)
5. Discontinuing SRMD prophylaxis  
Prophylactic therapy may be discontinued once patient is tolerating full feeds and has no more risk factors.

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# Stress Related Mucosal Disease (SRMD) Prophylaxis in The Intensive Care Unit

## SRMD Prophylaxis Algorithm



### Note:

Enteral feeding should be used whenever the GI is functioning well and normal absorption may be assumed.

# Blood Glucose Management in the Intensive Care Unit: Insulin Infusion Protocol

### Introduction

Stress hyperglycaemia is associated with poor clinical outcomes in critically ill patients. Factors contributing to hyperglycemia in critical illness include the release of stress hormones, the use of medications, the release of mediators in sepsis and trauma and insulin resistance.

### Principles

1. The aim is to maintain blood glucose level (BGL) between 6.0-10.0 mmol/l.
2. Glucose control needs to be implemented safely to avoid insulin induced hypoglycaemia.

### Insulin Protocol

1. Blood should ideally be sampled from the arterial line rather than capillary as the former is more accurate in critically ill patients.
2. Perform blood glucose level (BGL) on ICU admission. Start protocol when BGL exceeds 10 mmol/l for two consecutive readings, 1h apart.
3. For continuous intravenous insulin infusion, use soluble insulin 50 units in 50 ml 0.9% NaCl.
4. Blood glucose monitoring: Initially q1h until BGL is within goal for 2h, then q2-4h. If any of the following occurs, resume q1h monitoring until BGL is again stable.
  - a. Hypoglycemia episodes (<3.5 mmol/l)
  - b. Starting or stopping dialysis with dextrose containing dialysate
  - c. Starting or stopping TPN or enteral feedings
5. Patients who develop symptoms suggestive of hypoglycaemia e.g. tremors, tachycardia, sweating, confusion and agitation should have BGL checked.
6. Administration of insulin reduces potassium levels. Check K<sup>+</sup> at least twice daily and more often if the insulin infusion rate is high.



## Blood Glucose Management in the Intensive Care Unit: Insulin Infusion Protocol

7. Notify doctor if:
  - a. BGL < 3.5 mmol/l. Administer IV bolus of 25-50mls (12.5 -25g) Dextrose 50%. Repeat BGL in 15 minutes and repeat IV bolus if necessary. Restart insulin infusion if BGL > 10 mmol/l for 2 consecutive readings
  - b. Serum K<sup>+</sup> < 3.5 mmol/l, give IV KCl 1g over 1h via infusion pump
8. Patients should be converted to a standard hospital intermittent regimen (if required), before ICU discharge
9. Moving from one scale to another scale:
  - a. When the current BGL level is above target (> 10 mmol/l):
    - i. If the current BGL range is lower than the previous BGL range, stay in the same column
    - ii. If the current BGL range is the same or higher than the previous BGL range, move to the first right column with higher infusion rate
  - b. When the BGL is within target 6-10 mmol/l, stay in the same column
  - c. When BGL is 4- 6 mmol/l, move to the first column on the left with a lower infusion rate
  - d. Stop insulin infusion when infusion rate is stable at 0.5 U/hour for 2h

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# Blood Glucose Management in the Intensive Care Unit: Insulin Infusion Protocol

## Insulin Infusion Protocol in ICU

Maintain Blood Glucose Level (BGL) 6-10 mmol/l

ICU Admission - Perform BGL

If BGL > 10 mmol/l (2 consecutive readings 1h apart)

Start insulin infusion

BGL monitoring: Initially q1h until glucose is within goal for 2h, then q2-4h

Check serum K at least q12h

Initial Bolus		Start insulin infusion with Scale 2
BGL	Bolus	
mmol/l	Units IV	
>15	2	
10.1-14.9	1	

<b>Instructions: Compare the current BGL range to the previous BGL range</b>
If the current BGL range
1. <b>Lower:</b> Stay in the same column
2. <b>The Same Or Higher:</b> Move to the first right column with higher infusion rate
When BGL is within target: Do not change columns
When BGL 4- 6 mmol/l: Move to the first left column with lower infusion rate

Blood Glucose	Scale							
	1	2	3	4	5	6	7	8
mmol/l	Units/h							
≥22.1	3.0	4.0	5.0	6.0	7.0	8.0	10.0	11.0
18.1 - 22	2.5	3.5	4.0	5.0	6.0	6.0	8.0	9.0
14.1 - 18	2.0	3.0	3.0	4.0	5.0	5.0	6.0	7.0
12.1 - 14	1.5	2.5	2.5	3.0	4.0	4.0	4.0	5.0
10.1 - 12	1.0	2.0	2.0	2.0	3.0	3.0	3.0	4.0
8.1 - 10	1.0	1.0	1.5	1.5	2.0	2.0	2.5	3.0
6.1 - 8	0.5	1.0	1.0	1.0	1.5	1.5	2.0	2.0
4.1 - 6	0.5	0.5	0.5	0.5	1.0	1.0	1.5	1.5
< 4	Cease IV insulin infusion and inform doctor. Treat BGL < 3.5							

BGL mmol/l	Dextrose 50%	Action
1.5-3.5	25 mls (12.5g) IV push	<ul style="list-style-type: none"> <li>Repeat BGL in 15 minutes</li> <li>Repeat as necessary</li> <li>Restart insulin infusion if BGL &gt; 10 for 2 consecutive readings using first left column with lower infusion rate</li> </ul>
< 1.5	50 mls (25g) IV push	

Inform doctor if:
1. BGL < 3.5 mmol/l
2. Serum K < 3.5 mmol/l
3. BGL > 10 mmol/l for 2 consecutive measurements
4. Infusion rate is < 0.5 U/h for 2 consecutive measurements (to stop infusion)

# Early Mobilization for Patients in the Intensive Care Unit

### Introduction

Prolonged mechanical ventilation and stay in the intensive care unit are associated with functional decline and increased morbidity, mortality and cost of care. Implementation of early mobility has been shown to be beneficial.

### Principles

1. Early mobility should be started 24 to 48h after ICU admission in the absence of contraindications.
2. The program consists of progressive mobilization, with the progression based on a patient's functional capability and ability to tolerate the activity.
3. The following are exclusion criteria to early and progressive mobility.
  - i. Cardiovascular instability eg systolic blood pressure (SBP) < 90 mm Hg, heart-rate > 120 beats/min, unstable cardiac rhythm, and use of two or more vasopressors/inotropes
  - ii. Neurological instability eg acute traumatic brain injury, acute intracranial bleed, unstable spinal cord injury or any new neurological deterioration
  - iii. Respiratory instability eg  $F_iO_2 \geq 0.60$ , PEEP (positive end expiratory pressure) > 10 cm H<sub>2</sub>O, respiratory rate > 35 breaths/min

### Mobility Protocol

1. The mobility team should comprise of nurses, physiotherapists, and attendants
2. Patients and families should be informed the importance of early mobility
3. Level of activity therapy should be guided by the patient's conscious state and muscle strength. Refer to table below
4. Turn patients q2h except when contraindicated
5. Perform passive range of motion therapy q8h on all patients

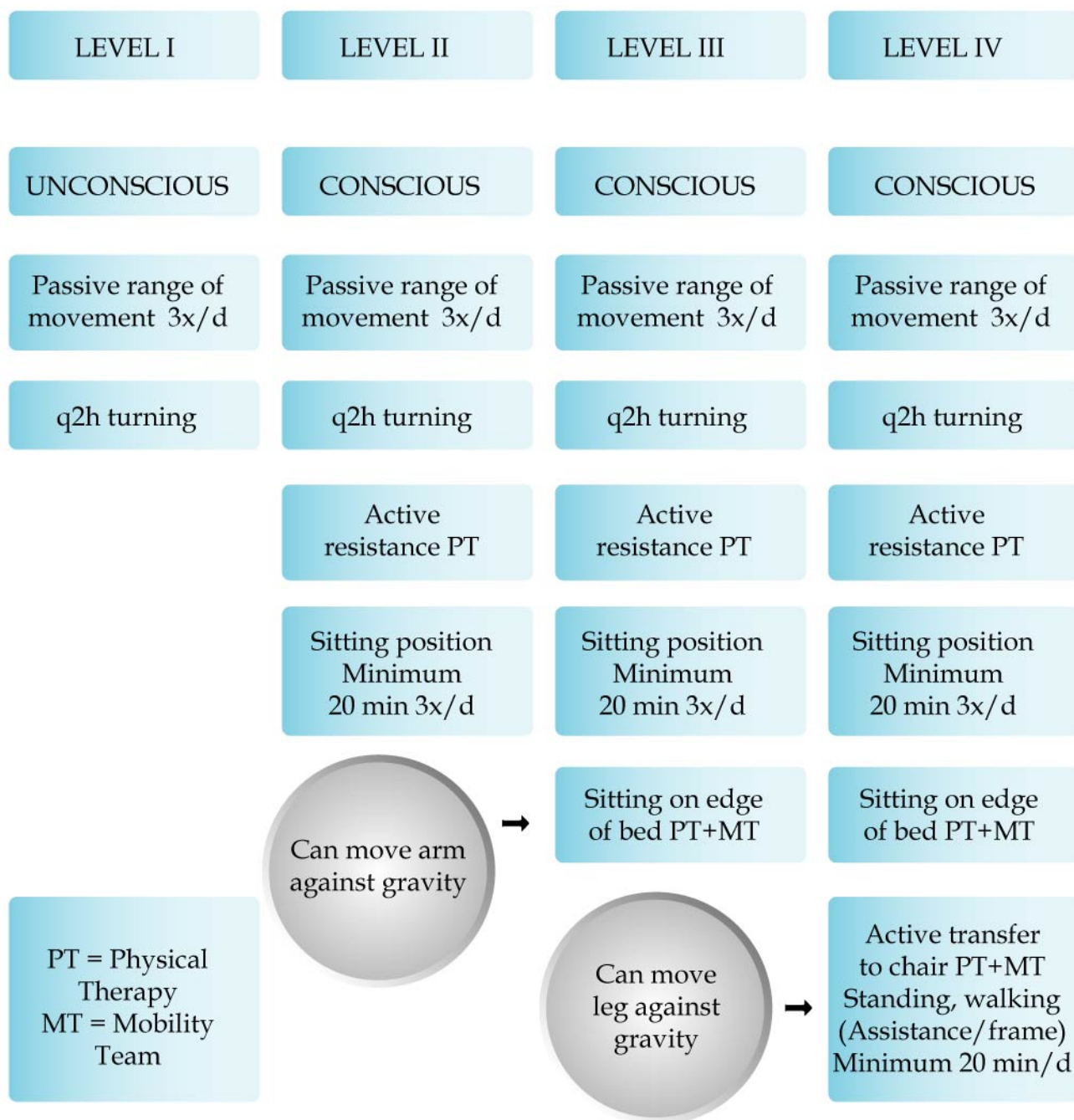


## Early Mobilization for Patients in the Intensive Care Unit

6. Perform active resistance physical therapy in conscious patients who are sufficiently alert to participate. The patients have to respond correctly to 3 of the 5 following commands:
  - i. Open or close your eyes
  - ii. Look at me
  - iii. Open your mouth and stick out your tongue
  - iv. Nod your head
  - v. Raise your eyebrows
7. Other physical activities may progress as below: (The duration of activity should be at least 20 minutes).
  - i. Breathing exercises
  - ii. Exercises for trunk control
  - iii. Sit up unsupported
  - iv. Sit on the edge of bed with legs in dependent position (partial chair position) and support upper body
  - v. Stand patients at bedside with support once patients are able to lift their legs against gravity. Patients should weight bear
  - vi. Transfer to chair by pivoting or taking 1-2 small steps. Patients should sit up for 1-2 h
  - vii. Allow selfcare activities e.g. self feeding
  - viii. Walk with assistance. Use walker if needed
  - ix. Walk independently
8. For patients on walking activity:
  - i. Adequate staff assistance must be available to ensure patient's safety
  - ii. A nurse must be present to assist and secure the tubes and catheters
  - iii. Patient must be followed with a wheelchair to allow resting periods and safe return to bedside if needed
  - iv. Full oxygen tank must be available
  - v. Evaluate signs and symptoms of fatigue throughout walking activity and terminate when indicated
9. Terminate any physical activity if any of the following signs or symptoms develops:
  - i. Oxygen saturation  $<88\%$
  - ii. Hypotension ieSBP  $<90$  mm Hg associated with dizziness, fainting, and/or diaphoresis
  - iii. Heart rate  $>120$  /min or presence of dysrhythmias
  - iv. Respiratory rate  $>30$  /min or change in breathing pattern with an increase use of accessory muscles and nasal flaring
  - v. Excessive sweating
  - vi. Significant chest pain
  - vii. Request of patient to stop



## Early Mobilization for Patients in the Intensive Care Unit



**Figure 1 (Reference 2)** Passive range of motion therapy (PROM) started on day 1 (level I). As patients demonstrated consciousness and increased strength, they were moved to the next higher level. Physical therapy (PT) would be first attempted at level II. For level activity II and above, referral to physiotherapy is advisable as the aim of rehabilitation is towards functional recovery.



## Early Mobilization for Patients in the Intensive Care Unit

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# Withholding and Withdrawal of Life Support Therapy in the Intensive Care Unit

### *Introduction*

The primary goal of intensive care is to prevent unnecessary suffering and premature death by treating reversible conditions for an appropriate period of time. Despite the utilisation of the best available resources, some patients do not respond to treatment, and death may still result. Even if the patient survives, unnecessary suffering with poor quality of life may ensue. With finite resources the provision of inappropriate treatment becomes even less acceptable and treatment should be withheld or withdrawn when deemed to be of no benefit.

Withholding and withdrawal of life support is a process through which various medical interventions are either not given to the patient or removed from them with the expectation that the patients will die from their underlying illnesses. There is no ethical or moral difference between withholding and withdrawal of life support therapy.

### *Principles of Withholding and Withdrawal of Life Support Therapy*

#### **1. Ethical principles of withholding and withdrawal of life support therapy**

The principles upon which end-of-life decisions are made are the same as the principles of medical ethics:

- a. beneficence (to do good)
- b. non-maleficence (to do no harm)
- c. autonomy
- d. social justice
- e. trustworthiness

#### **2. Capacity and surrogate decision-making**

- a. Clinicians should assess patient's decision-making capacity. This should include patient's ability to comprehend, appreciate, rationalize, and express his choice of treatment.
- b. If patients do not have decision-making capacity, the families become the surrogate decision-makers. However the decision for end-of-life is a medical decision made by clinicians with concurrence by family members.



## Withholding and Withdrawal of Life Support Therapy in the Intensive Care Unit

### 3. Autonomy and obligation to treat

- a. Patient autonomy must be respected after establishing decision-making capacity. In cases of refusal of treatment, patient's wishes should be respected although it may result in death.
- b. In cases of medical futility, clinicians are not obliged to initiate or continue life-sustaining therapy.

The MMA code of ethics 2001 conforms to this principle, that states *"where death is deemed to be imminent and where curative or life-producing treatment appears to be futile, ensure that death occurs with dignity and comfort. Such futile therapy could be withheld, withdrawn or one may allow irreversible pathology to continue without active resuscitation. One should always take into consideration any advance directives and the wishes of the family in this regard. In any circumstance, if therapy is considered to be life saving, it should never be withheld"*

### 4. Respect for the dying

All dying patients should be afforded the same standard of care as other patients. They should be treated with dignity, respect and compassion. Their privacy and confidentiality should be respected at all times.

### Patients for Withholding and Withdrawal of Life Support Therapy

The following patients are to be considered for withholding and withdrawal of life support therapy:

#### 1. A patient with imminent death

A patient facing imminent death has an acute illness whose reversal or cure would be unprecedented and will certainly lead to death during the present hospitalisation within hours or days, without a period of intervening improvement. This is a patient who is clearly not responding to therapy, and is reasonably unlikely to survive with continued therapy.

#### 2. A patient with terminal condition

A patient with a terminal condition has a progressive, unrelenting terminal disease incompatible with survival longer than 3 - 6 months. Intensive care treatment may be provided to treat superimposed, reversible condition only with clear and achievable goals in mind.



## Withholding and Withdrawal of Life Support Therapy in the Intensive Care Unit

3. **A patient with severe and irreversible condition impairing cognition and consciousness but death may not occur for many months**

In such cases, the decision is often not to initiate CPR or other resuscitative measures in the event of deterioration e.g. persistent vegetative state or severe dementia.

4. **A competent patient who has stated his/her wish not to initiate or to have life support withdrawn**

This will include patients who when competent have given clear wishes before the present episode of illness or those who have given do not resuscitate orders.



**Note:**

**Brain death** is a state in which the function of the brain as a whole, including that of the brainstem, is irreversibly lost. A patient who is certified brain dead is clinically dead, and therefore the withdrawal of life support therapy is the expected next course of action.

### Practical Issues of Withholding and Withdrawal of Life Support Therapy

1. **Medical team consensus**

The intensive care team and the primary team should ideally agree on end-of-life decisions. In the event of disagreement, time limited trial of therapy with definite goals should be established.

2. **Communication with patient and relatives**

- a. The discussion on end-of-life decisions should be made with the patient if he/she has decision-making capacity. Otherwise the discussion will be with the family.
- b. It is best that the same clinician (specialist/consultant) who is involved in the active care of the patient deals with the family. This clinician should be someone who has been frequently communicating with the family and has a rapport with them. A witness (nurse, doctor) should be present during these discussions.
- c. In the event of disagreement, allow
  - i. time limited trial of therapy with definite goals
  - ii. second medical opinion
  - iii. facilitation by a third party eg spiritual advisor
- d. Patients and families must be given sufficient time to reach decisions at the end-of-life.
- e. For strategies to improve end-of-life communication, refer to the Table 1.



# Withholding and Withdrawal of Life Support Therapy in the Intensive Care Unit

*Table 1. Strategies for Improving End-of-Life communication in the Intensive Care Unit (Truong RD et al: Crit Care Med 2008; 36:953-9 )*

## 1. Communication skills training for clinicians

## 2. ICU family conference early in ICU stay

Evidence-based recommendations for conducting family conference:

- Find a private location
- Increase proportion of time spent listening to family
- Use “VALUE” mnemonic during family conference
  - Value statements made by family members
  - Acknowledge emotions
  - Listen to family members
  - Understand who the patient is as a person
  - Elicit questions from family members
- Identify commonly missed opportunities
  - Listen and respond to family members
  - Acknowledge and address family emotions
  - Explore and focus on patient values and treatment preferences
  - Affirm non-abandonment of patient and family
  - Assure family that patient will not suffer
- Provide explicit support for decisions made by the family

Additional expert opinion recommendations for conducting family conference:

- Advance planning for the discussion among the clinical team
  - Identify family and clinician participants who should be involved
  - Focus on the goals and values of the patient
  - Use an open, flexible process
  - Anticipate possible issues and outcomes of the discussion
  - Give families support and time

## 3. Management plan for withdrawal of life support therapy

A clear plan of management for withdrawal of life support therapy is important to ensure that the process occurs smoothly. The plan should be reviewed with the patient and family, with an emphasis on maintenance of comfort for the patient.



## Withholding and Withdrawal of Life Support Therapy in the Intensive Care Unit

The plan for withdrawal of life support therapy should have the following components:

- a. All forms of life support are maintained until the patient and family have had enough time together.
- b. Ensure patient comfort with attention to pain control and other symptom control e.g. dyspnoea, thirst and hunger throughout the process of withdrawal.
- c. Relief of pain and discomfort:
  - i. Morphine is the most common opioid used for relieving pain without any maximum dose.
  - ii. "Double effect" of opioids - maximises pain relief and may hasten death. This is an acceptable concept.
  - iii. Benzodiazepines are also used to treat anxiety.
- d. Therapies or medications that do not provide a net positive contribution to the comfort of dying patients should be discontinued e.g. antibiotics, renal replacement therapy, radiological examinations, blood transfusions.
- e. Withdrawal of vasopressors may result in immediate death and therefore it should be carried out when the family is ready.
- f. There are two strategies for withdrawal of mechanical ventilation:
  - i. Terminal weaning - gradually reducing the ventilator settings while leaving the endotracheal tube in situ
  - ii. Terminal extubation - removal of the endotracheal tube
- g. The alarms on the monitors should be disabled and the family should be allowed to be with the patient if they choose to.
- h. The patient's personal hygiene and dignity should be maintained at all times.

#### 4. Considerations around specific therapies

- a. The use of noninvasive ventilation during end-of-life care should be evaluated by carefully considering the goals of care. Non-invasive ventilation may be used as a palliative technique to minimise dyspnoea.
- b. Neuromuscular blockade should not be used as they are not beneficial for the patient, and make it impossible to assess patient's level of comfort.



## Withholding and Withdrawal of Life Support Therapy in the Intensive Care Unit

### 4. Documentation

All decisions regarding the withdrawing or withholding of treatment should be documented. This should include the basis of the decision as well as amongst whom the consensus had been reached.

### 5. Notification of death

The death should be communicated in plain language gently and emphatically. Provide bereavement support to the family and health-care providers if needed.

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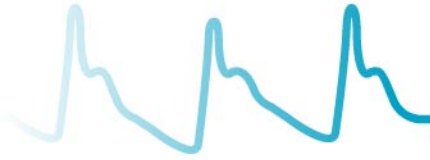
# Policy on Mechanical Ventilation outside the Intensive Care Unit

### Introduction

Mechanical ventilation outside the intensive care unit eg in the ward is undesirable and should be discouraged. However, given the current circumstances where resources are limited, this may not be always possible.

### *Policy on the care of the patient on ventilator outside the intensive care unit:*

1. Patients who are ventilated outside the intensive care unit can be categorized into 3 groups:
  - a. Patients who have a reasonable prospect of meaningful recovery but not admitted due to unavailability of ICU bed
    - Every effort should be made to admit them to ICU as soon as possible.
  - b. Patients whose initial prospect of meaningful recovery is uncertain and not admitted due to unavailability of ICU bed
    - Effort should be made to admit them to ICU if they subsequently show improvement.
    - Effort should be made to withhold and withdraw therapy if they subsequently deteriorate.
  - c. Patients with minimal or no prospect of meaningful recovery
    - They should be managed by the primary team with efforts made to withhold and withdraw therapy.
2. The overall care of the patients ventilated outside the ICU remains with the primary team, including resuscitation.
3. The ICU doctor shall review the patient once a day and manage the ventilatory aspects of patient care.



## Policy on Mechanical Ventilation outside the Intensive Care Unit

4. Nursing care of patients on ventilator includes the following:
  - i. Monitor the patient eg facial expression, colour, respiratory effort, pulse oximetry or ECG tracing and document the patient's vital signs hourly
  - ii. Elevate head of bed 30 degree
  - iii. Ensure the endotracheal tube (ETT) or tracheostomy tube is held securely in position while avoiding pressure sores
  - iv. Perform tracheal and oropharyngeal suctioning q4h, more often if necessary
  - v. Perform q4h positioning of the patient
  - vi. Perform oral toilet daily
  - vii. Perform eye care by applying artificial tears every shift
  - viii. Ensure the patient has a nasogastric tube for gastric decompression or nutritional support
  - ix. Ensure that self-inflating bag, Yankeur sucker, suction catheters and suction unit, airway and mask are available and functioning